THE EFFECT OF TIME FROM LAST FOOD INTAKE ON ARTERIAL BLOOD GASES : IMPLICATION ON REFERENCE VALUES

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Abstract - *Arterial blood gas parameters were analyzed in forty-nine healthy persons (31 males, 18 females) to determine reference values for these parameters and their relation to the time from last food intake to arterial puncture (T). The mean ± standard deviation of arterial oxygen pressure, arterial carbon dioxide pressure and pH at core body temperature were 84.4 ± 7.0 mmHg (Male : 83.0 ± 6.5, Female: 86.7 ± 7.3), 37.7 ± 2.8 mmHg (Male: 38.5 ± 2.7, Female: 36.2 ± 2.4), respectively 7.41 ± 0.02 (Male: 7.41 ± 0.02, Female: 7.42 ± 0.03). The mean PCO_2 was lower in comparison with most of the studies at sea level. The difference between males and females was significant in PCO_2 and pH ($P = 0.004$, $P = 0.02$ respectively) but it was not significant in PO_2 ($P = 0.07$). The PCO_2 and pH had no statistically significant relationship with age ($P = 0.42$, $P = 0.25$ respectively). The relationship between PO_2 with age, PCO_2 and T was significant ($P = 0.02$, $P = 0.014$, and $P = 0.019$ respectively). The best linear predictive equation was: $PO_2 = 1.28\ AO2\text{-}29.4$ for $T < 10$ hours $\Rightarrow AO2 = 0.21\ (Baro - 47) - (1 + 0.02T)\ PCO_2$ for $T > 10$ hours $\Rightarrow AO2 = 0.21\ (Baro - 47) - (1.2\ PCO_2$*

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Key Words: Arterial oxygen pressure; blood gas parameters; metabolism; predictive equation; respiratory exchange ratio; respiratory quotient

INTRODUCTION

In current clinical practice, blood gas analysis is performed with increasing frequency as part of respiratory assessment. Nevertheless, most of the reference values of blood gas parameters used worldwide have been obtained in the past (1) and there is little data about blood gas reference values in Iran.

It is generally accepted that alveolar - arterial oxygen pressure difference ($D_{(A-a)}\ O_2$) is a reliable indicator of ventilation - perfusion (V/Q) mismatch (2,3). Calculation of ($D_{(A-a)}\ O_2$) requires the determination of ideal alveolar oxygen pressure (PAO_2). The most commonly used equation for ideal alveolar oxygen pressure uses the measured or estimated respiratory exchange ratio (RER). In the steady state, RER equals respiratory quotient (RQ) and depends on the main fuels of metabolism (2,4). Thus it is hypothesized that the time from the last food intake to arterial puncture (T) can alter blood gas parameters by changing main fuels of metabolism. The aim of this study was to determine: the reference values of blood gas parameters in our center; the effect of T on arterial gas parameters; and the validity of assumed value of R.E.R = 0.8 for clinical purposes.

MATERIALS AND METHODS

This study was performed on 188 non-paid volunteers in Imam-Khomeini Medical Center located in the central part of Tehran, where the barometric pressure is 664 mmHg. The study population comprised of medical students, patient attendants and other people who were informed about the study by a public announcement. All volunteers signed a consent form after the purpose and procedures used in the study were explained to them. Subjects were excluded if they had any significant problems on the basis of history, physical examination, chest X-ray, spirometry, urinalysis and blood chemistry. Five persons were excluded because their FVC or FEV1 were below the 5th percentile of predicted values(5).

Arterial blood was obtained after five minutes of rest (sitting and breathing room air). Arterial blood samples were obtained in disposable preheparinized 2 ml syringes from the radial artery after Allen's test according to Sabin's method (6). The samples were analyzed in less than two minutes by AVL-995 blood gas alanyzer. The analyzer was calibrated according to the manufacturer's guidelines with tonometric ampoules (7). The standard gas mixtures for calibration were not available. The results were recorded according to 37 °C and the core body temperature (Oral temperature +

0.6 °C).

Statistic Methods

Values are expressed as mean ± standard deviation. Descriptive statistics and two sample t-test and correlation (Pearson) and linear regression analysis were performed using SPSS statistical analysis software. The data distribution was analyzed with Kolmogrow - Smirnow Goodness of Fit Test by SPSS. Statistical significance was accepted at the 95% confidence level (P-value < 0.05).

RESULTS

Of the 188 subjects examined, 49 were found to be eligible according to the criteria described above. Table 1 shows the anthropometric variables and blood gas results by sex distribution of arterial oxygen pressure (PO_2) and arterial carbon dioxide pressure (PCO_2) and pH. The difference between males and females was significant in PCO_2 and pH ($P = 0.004$, $P = 0.02$ respectively) but it was not significant in PO_2 ($P = 0.07$). The PCO_2 and pH had no statistically significant relationship with age ($P = 0.42$, $P = 0.25$ respectively).

Table 2 shows the correlation coefficient between PO_2 with age, PCO_2, T and body mass index (BMI). The correlation between PO_2 with age, PCO_2 and T were significant.

The predictive equation of PO_2 according to PCO_2, age, AO_2 and $[PAO_2]_s$ was compared (Table 3). As shown in table 3, the best linear prediction is by AO_2 ($R^2 = 0.39$, SEE = 5.5, Fig. 1).

DAO_2 (AO_2 - PO_2) and $[P(A\text{-}a)O_2]_s$ ($[PAO_2]_s$ - PO_2) were compared in regard to T. The distribution of these parameters were gaussian ($DAO_2 = 4.6 \pm 5.5$, $[P(A\text{-}a)O_2]_s = -0.1 \pm 6.1$). The relationship between these parameters with age and sex were not statistically significant. $[P(A\text{-}a)\ O_2]_s$ had statistically significant relationship with T ($P = 0.004$) but the relationship between PAO_2 with T was not statistically significant ($P = 0.69$).

Table 1. Individual characteristics and blood gas results (Imam-Khomeini Medical Center, 1995)

	Male	Female	Pvalue (Male vs Female)
Number	31	18	
Age (year)	29 ± 8	33 ± 12	0.23
Arterial PO_2	83 ± 7	87 ± 7	0.07
Arterial PCO_2	39 ± 3	36 ± 2	0.004
Arterial pH	7.41 ± 0.02	7.42 ± 0.03	0.02

Table 2. Correlation coefficient between PO_2 with age, PCO_2, T* and BMI** (Imam-Khomeini Medical Center, 1995)

	age	PCO_2	T	BMI
Arterial PO_2	-0.33	-0.35	-0.34	-0.14
Pvalue	0.020	0.014	0.019	0.35

* Time from last food intake to arterial puncture

** Body Mass Index

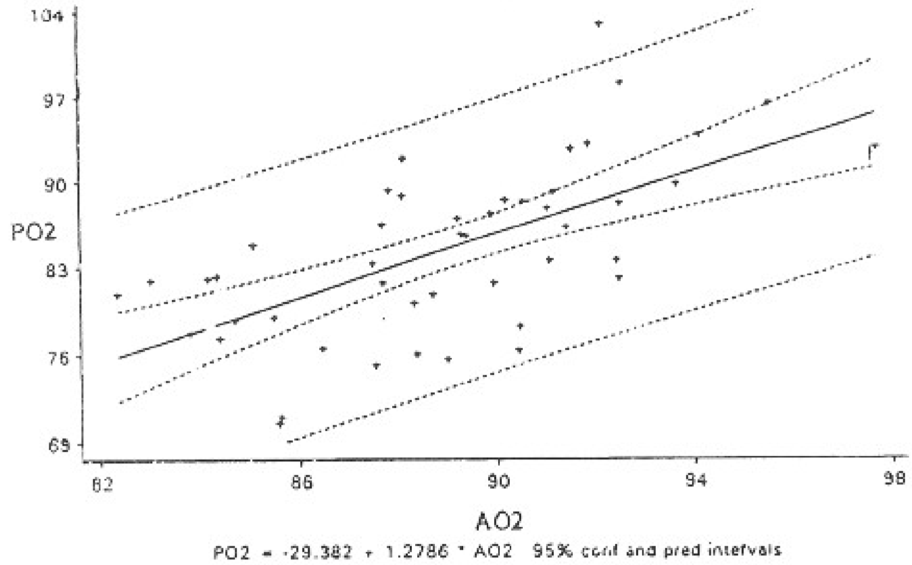

Fig. 1. Simple Regression Plot

Table 3. Predictive equation of PO_2 according to PCO_2, age, $[PAO_2]_s$**, AO_2* (Imam-Khomeini Medical Center, 1995)

Predictive equation	R^2	SEE	Pvalue
$PO_2 = 117.08 - 0.87\ PCO_2$	0.12	6.58	0.0140
$PO_2 = 91.78 - 0.24\ Age$	0.11	6.62	0.0195
$PO_2 = 1[PAO_2]_s - 0.16 Age + 4.34$	0.27	5.99	0.0009
$PO_2 = 1.28\ AO_2 - 29.38$	0.39	5.465	0.0000

* $[PAO_2]_s = 0.21\ (Baro - 47) - 1.2\ PCO_2$

** For T < hours $AO_2 = 0.21\ (Baro - 47) - (1 + 0.02T)\ PCO_2$

For T > 10 hours $AO_2 = 0.21\ (Baro - 47) - 1.2\ PCO_2$

DISCUSSION

The mean ± SD of PCO_2 was 37.7 ± 2.8 mmHg (Baro = 664 mmHg, Mean temperature = 37.5' C). Although hyperventilation at sea level should be considered but the reported PCO_2 at sea level and highlands shows very broad variation (e.g. there was no significant difference between PCO_2 mean in this study and Cerveri's study at altitude of sixty meters (1).

The reported PCO_2 in the northern part of Tehran (Baro = 650 mmHg) and in Salt Lake City (Baro = 640 mmHg) were 32.3 ± 4.1 mmHg and 30.6 ± 3.6 mmHg respectively (8,9) were significantly lower than our results. For this reason we suggest that spirometery arterial blood gas results should be interpreted by the individual laboratory's reference values, which are influenced by the center's methods, altitude, and cases.

There are many reports that PO_2 decreases with age. The coefficient of age in our predictive equation is almost equal to Rain's and Conway's studies (11,12) but it is lower than others (1,13,14). One of the main differences between our study and most other studies is our younger population. Only 12% of our cases were above forty years.

In a recent study (1) Cerveri reported the relationship between PO_2 and PCO_2 in subjects younger than 75 years. However in subjects older than 75 years, there was no correlation between PO_2 with age, BMI and PCO_2. He attributed this PO_2 and PCO_2 relationship to different magnitudes of oxygen and carbon dioxide stores. However he did not explain why there was no correlation between PO_2 and PCO_2 in subjects older than 75 years.

In our opinion the relationship between PO_2 with PCO_2 originates the relationship between alveolar oxygen and carbon dioxide pressures that can be presented by Riley and Cournard's model (2). The fact that Riley and Cournard's model is a better model to explain the relationship between PO_2 with PCO_2 is reflected in the better correlation between PO_2 with AO_2 than PCO_2.

We proposed the AO_2 concept according to the idea of ideal alveolar air of Riley and Cournard and we compared it with $[PAO_2]_s$ as proposed by Begin and Renzetti (9).

The proposition of (1 + 0.02 T) as PCO_2 coefficient in AO_2 definition relies on the following points :

1- Tissue carbohydrate consumption is maximum after half to one hour of carbohydrate ingestion (15). In the studies with high carbohydrate ingestion, the mean RQ was little above one (16-18). In Saltzman's study, it was between 0.98 ± 0.05 to 1.1 ± 0.06 and in Askanzi's studies it was 1.07 for healthy men, and 1.0 ± 0.03 and 1.04 for malnourished men. However it should be considered that in actual life the person takes food for about 1/4 - 1/2 hours, several times throughout day and the amount of carbohydrate is less than these studies. Therefore the assumption that RQ is about 0.98-1 in the first hour after taking food is acceptable.

2- After 12-15 hours of fasting the mean RQ is about 0.8 (15,19). Consequently PCO_2 coefficient (1 + $[1 + FIO_2]/R$ (according to Riley and Cournard model) is about 1.2. After 36 hours of fasting the mean RQ mean is about 0.7 (19) (PCO_2 coefficient is about 1.25). Therefore it is assumed that after 10 hours of fasting, the PCO_2 coefficient is about 1.2 and there is no further significant change.

3- Although the relationship between PCO_2 coefficient and T is probably not linear in real life, this could be a useful simplifying approximation.

The significant correlation between PO_2 and T and the better prediction of PO_2 by AO_2 in comparison with $[PAO_2]_s$ demonstrates the role of T. This finding is anticipated by the dependency of RQ on metabolism (2,4). The effect of nutritional status on PO_2 standard values has previously been emphasized by Saltzman and Salzano (16). In conclusion, the time from last food intake to arterial puncture can alter PO_2 probably by an effect on the main fuel of metabolism. In our study PO_2 prediction improved when T was introduced in the prediction equation. Further studies are required to determine the significance and applicability of our estimation of ideal alveolar oxygen pressure (AO_2) in clinical situations.

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