Original Article

Comparison of arterial and venous blood gas values in cardiac surgery

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ABSTRACT

Objective: To determine whether venous blood gas values can replace arterial gas values during cardiac surgery. We investigated the correlation of pH, Po_2, Base Excess and HCO_3 in arterial and venous blood gases.

Methods: This prospective study was performed on 150 patients undergoing cardiac surgery in Shahid Madani Heart Hospital in Tabriz, Iran in 2004. We measured of the arterial and venous blood gases perioperative phase of cardiac surgery.

Results: There was not any significant difference between HCO_3 in arterial and venous samples, during and after surgery and intensive care unit (ICU) with FIO2=70% (P=0.767, 0.593, 0.399) respectively. The correlation was just acceptable in pH at the beginning of surgery (r=0.858).

Conclusions: There were considerable correlations between pH and HCO_3 but not in $P_{CO2,}$ and $P_{O2.}$ We do not recommend venous blood gas for determining PO_2, PCO_2. (Rawal Med J 2008;33:29-32).

Key Words: ABG, venous blood, CABG, pH, Acid base.

INTRODUCTION

Measurement of the arterial blood gases, before, during and after cardiac surgery has an extreme significance. This controlling even has double importance in the ICU. Arterial blood gas (ABG) sampling represents the gold standard method for acquiring patients' acid-base status.[1,2] The most common complications associated with arterial puncture are pain, arterial injury, local hematoma, infection, thrombosis with distal ischemia, emboli, hemorrhage, aneurism formation, and technical difficulties and potential hazards for sampler.[3] The risks increase with repeated arterial punctures and with insertion of a catheter when performed by inexperienced individuals. Venous Blood Gas (VBG) samplings may be useful alternatives as it is easier to obtain and a less invasive way of evaluating acid-base status, avoiding the risks of arterial punctures.[1,2,4] Several studies have shown good correlation between venous, and arterial blood gas values.[5,6] The aim of this study was to investigate the correlation of pH, PO_2, Base Excess (BE) and HCO_3 in arterial and venous blood.

PATIENTS AND METHODS.

This prospective study was carried out on 150 patients undergoing cardiac surgery in Shahid Madani Heart Hospital in Tabriz, Iran in 2004. The studied patients underwent valvular surgery, CABG, or both. The data collected in ICU operating room (OR). Variables noted were age, gender, Ejection Fraction (EF) before and after intubation in ICU, use of inotropic agents, duration of ICU stay, complications (e.g. central nervous system, pulmonary, cardiac, and renal), and general condition when patients is discharged.

Five arterial and venous samples, at the beginning, during, and end of operation, and in ICU with FIO_2 70% and 35% were taken. Arterial blood sampling was performed from radial artery and venous blood was sampled from CVP line. The sampled blood underwent blood gas analysis with determination of pH, PCO_2, BE, HCO_3, PO_2, and O_2 saturation. The statistical analysis was based on SPSS software and was done through descriptive statistical methods.

RESULTS

We studied 150 male patients, with average age of 57.08±13.03 years. Of all patients, 113 (75.3%) had CAD (underwent CABG), 24 (16%) had valvular disease (underwent valvular surgery) and 13(8.7%) had both valvular and CAD (underwent concomitant valvular surgery and CABG). The mean EF were 47.98±9.84% and 44.55±9.53% pre and post operation respectively. The average duration of intubation and stay in ICU were 16.51±16.10 hours and 3.91±4.62 days respectively. Inotropic support was used in 74 cases (49.3%). Bicarbonate content of the arterial and venous blood samples during (P=0.767) and after operation (P=0.593), and in ICU (P=0.399) with FIO_2 70% was not significantly different. Other variables between arterial and venous blood sampled during and after operation and in ICU were significantly different (table 1).

Table 1. Variables between arterial and venous blood sampled during and after operation and in ICU.

		Arterial	Venous	Correlation	P-Value
Acidity	Before operation	7.40±5.62	7.35±5.62	0.858	0
	During operation	7.41±6.97	7.35±6.97	0.724	0
	After operation	7.37±6.20	7.30±6.20	0.752	0
	In ICU with FIO2=70%	7.35±5.58	7.29±5.58	0.799	0
	In ICU with FIO2=35%	7.38±4.41	7.32±4.41	0.726	0
P_{CO2}	Before operation	35.14±5.88	40.53±5.88	0.638	0
	During operation	32.16±9.62	35.83±9.62	0.387	0
	After operation	33.32±5.56	39.35±5.56	0.741	0
	In ICU with FIO2=70%	36.42±5.56	43.20±5.56	0.444	0
	In ICU with FIO2=35%	38.47±4.38	46.99±4.38	0.207	0.005
Base Excess	Before operation	-1.88±2.60	-2.78±2.60	0.635	0
	During operation	-3.89±3.00	-5.05±3.00	0.728	0
	After operation	-4.35±2.91	-6.14±2.91	0.570	0
	In ICU with FIO2=70%	-4.18±2.85	-5.59±2.85	0.551	0
	In ICU with FIO2=35%	-2.09±2.33	-2.82±2.33	0.520	0.3
HCO3-	Before operation	21.72±2.36	22.25±2.36	0.567	0.050
	During operation	20.07±2.52	20.14±2.52	0.595	0.767
	After operation	19.22±2.09	19.34±2.09	0.614	0.593
	In ICU with FIO2=70%	20.13±2.29	20.34±2.29	0.538	0.399
	In ICU with FIO2=35%	22.37±2.19	22.95±2.19	0.497	0.017
P_{O2}	Before operation	325.23±104.24	45.41±104.24	-0.018	0
	During operation	362.74±142.30	45.65±142.30	0.311	0
	After operation	253.76±114.16	41.95±114.16	0.224	0
	In ICU with FIO2=70%	154.20±72.07	38.22±72.07	0.204	0
	In ICU with FIO2=35%	148.90±74.70	38.97±74.70	0.222	0
O2 saturation	Before operation	99.76±0.33	77.11±8.08	0.113	0
	During operation	99.63±0.69	75.65±14.46	0.397	0
	After operation	99.14±1.63	69.62±9.15	0.141	0
	In ICU with FIO2=70%	97.42±3.61	63.07±10.49	0.186	0
	In ICU with FIO2=35%	97.63±2.53	68.04±7.10	0.189	0
O2 content	Before operation	21.76±0.37	16.17±1.70	-0.006	0
	During operation	21.93±0.59	16.06±3.11	0.585	0
	After operation	21.35±0.77	14.6±1.91	0.221	0
	In ICU with FIO2=70%	20.80±0.76	13.28±2.06	0.209	0
	In ICU with FIO2=35%	20.77±0.71	14.27±1.51	0.165	0

Bicarbonate content of the arterial and venous blood sampled at the OR was not significantly different (P=0.09), but other variables were significantly different (table 2).

Table 2. Variables between arterial and venous blood sampled in ICU and OR.

		Arterial	Venous	Correlation	P-Value
Acidity	OR	7.40±0.06	7.33±0.07	0.764	0
	ICU	7.36±0.05	7.31±0.05	0.779	0
PCO2	OR	33.54±7.34	38.57±7.93	0.546	0
	ICU	37.45±5.10	45.09±27.21	0.212	0
Base Excess	OR	-3.37±3.03	-4.66±3.90	0.690	0
	ICU	-3.13±2.80	-4.21±3.82	0.599	0
HCO3-	OR	20.34±2.55	20.57±3.84	0.639	0.09
	ICU	21.25±2.50	21.65±3.68	0.592	0.022
P_{O2}	OR	313.91±129.22	44.33±11.86	0.253	0
	ICU	151.55±73.32	38.59±5.36	0.207	0
O2 saturation	OR	99.51±1.07	74.13±11.37	0.245	0
	ICU	97.53±3.11	65.55±9.28	0.189	0
O2 content	OR	21.68±0.64	15.61±2.43	0.398	0
	ICU	20.79±0.73	13.77±1.87	0.177	0

DISCUSSION

To our knowledge, there has not ever been a study as ours about adult cardiac patients. There have been high correlation rates between pH and the amount of bicarbonate.[6-8] Some studies comparing ABG and VBG samples have shown good correlation among ABG and VBG samples.[5,9] In fact, most of the studies comparing various blood gases have been done mainly in stable patients. Arterial and venous pH results (r = .9689) and arterial and venous HCO3- results (r = .9543) were highly correlated and showed a high measure of agreement in ER setting in patients with diabetic ketoacidosis.[10] Venous pH correlated well and was precise enough with arterial pH to serve as a substitute.[11]

In tricyclic antidepressant poisoning, the peripheral venous pH measurement has been a valid and reliable substitute for arterial pH.[12] Oximetry and dorsal hand venous carbon dioxide tension were found to be useful alternative to arterial puncture.[3] Arterial and venous pH results (r = 0.87), P_{CO2} results (r = 0.81), and HCO3- results (r= 0.88) were highly correlated in acutely ill patients.[6] Kirubakaran suggest that Even though arterial blood gas analysis is the gold standard, and when an arterial blood gas sample cannot be obtained, a combination of arterialized capillary blood gas and pulse oximetry can be effectively used in acutely ill children of all ages.[2] Chu et al concluded that venous blood gas can accurately predict the ABG values of pH, PCO_2 and HCO_3 for patients with acute respiratory failure being treated with mechanical ventilation.[13] There was a significant correlation in pH, PCO_2, PO_2, BE, and HCO_3 among ABG, VBG, and CBG values inpediatric patients, except for a poor correlation in PO_2 in the presence of hypotension.[5] Venous pH estimation is an acceptable substitute for arterial measurement and may reduce risks of complications both for patients and health care workers,[14] especially in ICU setting.[8] Malinoski et al showed that although VBGs cannot be substituted for ABGs in mechanically ventilated trauma patients during the initial phases of resuscitation, clinically reliable conclusions can be reached with VBG analysis.[15]

To date, there was not any article such our one about patients with cardiac surgery disease. In our study, the only value with high correlation was arterial and venous blood pH before operation (r = 0.858), which is compatible with other studies. However, except for HCO_3 levels during operation (P=0.767), after operation (P=0.593), and in ICU with FIO2=70% (P=0.399), there was significant difference between other values. Thus, except for determination of these 3 values, VBG is not a valid and reliable substitute for ABG; and this result is not compatible with other studies. Comparison of ICU and OR samples showed that despite the high correlation between assessed parameters, the difference of average values of the results is significant, except for HCO^3 level in OR. In conclusion, there were considerable correlations between pH and the amounts of bicarbonate. Therefore, we do not

recommend VBG for determining oxygenation and P_{CO2}, although there is correlations between the pH and bicarbonate values.

REFERENCES

1. Trowbridge CC, Vasquez M, Stammers AH, Glogowski K, Tremain K, Niimi K, et al. The effects of continuous blood gas monitoring during cardiopulmonary bypass: a prospective, randomized study--Part II. J Extra Corpor Technol. 2000;32:129-37.
2. Kirubakaran C, Gnananayagam JE, Sundaravalli EK. Comparison of blood gas values in arterial and venous blood. Indian J Pediatr. 2003;70:781-5.
3. Elborn JS, Finch MB. Non-arterial assessment of blood gas status inpatients with chronic pulmonary disease. Ulster Med J 1991;60:164-167.
4. Rees SE, Toftegaard M, Andreassen S. A method for calculation of arterial acid-base and blood gas status from measurements in the peripheral venous blood. Comput Methods Programs Biomed. 2006;81:18-25.
5. Yildizdas D, Yapicioglu H, Yilmaz HL, Sertdemir Y. Correlation of simultaneously obtained capillary, venous, and arterial blood gases of patients in a paediatric intensive care unit. Arch Dis Child 2004; 89: 176-180.
6. Gennis PR, Skovron ML. The usefulness of peripheral venous blood in estimating acid-base status in acutely ill patients. Ann Emerg Med 1985;14:845-849.
7. McGillivray D, Ducharme F M. Clinical decisionmaking based on venous versus capillary blood gas values in the well-perfused child. Ann Emerg Med 1999;34:58-63.
8. Middleton P, Kelly AM, Brown J, Robertson M. Agreement between arterial and central venous values for pH, bicarbonate, base excess, and lactate. Emerg Med J. 2006;23:622-4.
9. Brandenburg MA, Dire DJ. Comparison of arterial and venous blood gas values in the initial emergency department evaluation of patients with diabetic ketoacidosis. Ann Emerg Med 1998;31:459–65.
10. Brandenburg MA, Dire DJ. Comparison of arterial and venous blood gas values in the initial emergency department evaluation of patients with diabetic ketoacidosis. Ann Emerg Med 1998;31:459-465.
11. Ma OJ, Rush MD, Godfrey MM, Gaddis G. Arterial blood gas results rarely influence emergency physician management of patients with suspected diabetic ketoacidosis. Acad Emerg Med. 2003;10:836-41.
12. Eizadi-Mood N, Moein N, Saghaei M. Evaluation of relationship between arterial and venous blood gas values in the patients with tricyclic antidepressant poisoning. Clin Toxicol (Phila). 2005;43:357-60.
13. Chu YC, Chen CZ, Lee CH, Chen CW, Chang HY, Hsiue TR: Prediction of arterial blood gas values from venous blood gas values in patients with acute respiratory failure receiving mechanical ventilation. J Formos Med Assoc 2003;102:539-543.
14. Kelly AM, McAlpine R, Kyle E. Agreement between bicarbonate measured on arterial and venous blood gases. Emerg Med Australas. 2004;16:407-9.
15. Malinoski DJ, Todd SR, Slone S, Mullins RJ, Schreiber MA. Correlation of central venous and arterial blood gas measurements in mechanically ventilated trauma patients. Arch Surg. 2005;140:1122-5.