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A Comparative Study of Arterial Blood Gas (ABG) Values in Relation with Time and Temperature

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Abstract

We conducted a comparative study, and compared the arterial blood gas valves with respect to time 0, 5, 10, 15, 20 *mins* after sample collection and temperature at 0 oc and 22 0c degree arterial blood gas sample was collected from dorasalis pedis artery before induction of general anesthesia in 100 patients of ASA Grade I and II posted for all type of elective surgeries. The samples were randomly allocated into two groups. In Group A at 0 degree Celsius, and in Group B, 22 *degree Celsius*. parameter noted pH, pCO_2, pO_2, standard bicarbonate, base excess, O_2 and CO_2 at 0, 5, 10 , 15 and 20 *minutes*. Statistical analysis was done with *t*-test.

Keywords: Ph - Hydrogen ion concentration; pCO_2- Partial pressure of CO_2; pO_2 - Partial pressure of O_2; O_2 - Oxygen content; CO_2 - CO_2 content; BE - Base excess.

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Introduction

- ABG analysis plays an important part in management of patients in OTs/ ICUs
- Delayed analysis, storage fallacies may cause altered results, influencing patient management

Materials and Methods

We conducted the study in Basaveswara Medical College and Hospital and Research Centre, Chitradurga.

Patients

- 100 ASA I/II patients of either sex (*18–55 yr*) posted for Elective major surgeries;
- Between *Sep. 2017* and *Aug. 2018*

The Machine

Ciba Corning 248 ABG Analyzer ;

Cold Storage/Ice pack;

Lab thermometer (*0°C–50°C*).

Exclusion Criteria

- Patient Refusal;
- Sepsis and fever;
- Significant coagulation defects;
- In-sufficient collaterals in 'sampling' limb;
- Suspicion of incorrect storage (air/temp).
- Routine PAE;
- Investigations incl. Hb%;
- Patient Explanation and Consent;
- Midazolam @ *0.02 mg/Kg* I.V.
- Basal Monitors connected.

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Methods

- Samples collected anerobically in *2 ml* heparinised syringes from Dorsalis pedis Artery:

  before induction of GA (FiO_2 = 0.21) under LA (22 # 'Venflon');
- Allotted randomly to 2 Groups of 50 each and samples analyzed:

  Group A: Stored/transported at *0°C*;

  Group B: Stored at *22°C* (Lab temp).

Parameters noted

- pH, PcO_2, PO_2 and
- Standard Bicarbonate., BE, O_2 & CO_2 Content at *0, 5, 10, 15 and 30 minutes.*

Compared within each Group and statistically analyzed with paired *t*-test (SPSS for Windows version 16).

Machine Factors and Error

pH: 6.5–8.00 pCO_2: *5–250 .0 mm Hg*

pO_2: 0.0–749.0 P_{atm}: *400–825 mm Hg*

Temp: *15°C–32°C* HCO_3 (act or std): *0.0–60.0 mmol/l*

BE (ecf or B) : ±*29.9 mmol/l*

$CTCO_2$: *0.0–60.0 mmol/l*

O_2SAT : 0.0–100% O_2CT : *0.0–40.0 ml/dl*

PO_2 (A-a) : *0.0–749.0 mm Hg* (*0.0–99.86 kpa*)

PO_2 (a/A) : 0.0–1.00

Results

Group A (*0°C*):

1. pH remained extremely stable in > 80% of patients and varied minimally in the rest: from - 0.21 to + 0.40% (*0.015 unit fall*);
2. pCO_2 Very minimal changes. (-0.4 to + 0.2%) Not Significant …(*0.08 mm Hg* average ⇑);
3. pO_2 Remained stable with small falls but statistically in-significant relative increases at *30 min* (Fall of *2.03 mm Hg* at *30 min*);
4. Bicarbonate Minimal changes at *5 min* to no changes later : - 3.43 to + 7.93;
5. BE not much significant change
6. O_2 content No significant change;
7. CO_2 content Minimal changes throughout.

Group B ***(22°C):***

1. pH- Varied by: - 0.37% to + 0.40% over *30 min period* Overall, very stable *14 pts* and slightly fell in rest (36) there was relative falling trend from *15 Min* onwards (Mean *0.317%* or *0.024 Units*)
2. pCO_2- Varied by: -9.19% to + 8.76%, majority having a rise throughout but a relative fall at *15 min*. (Av. rise of *2.1 mm Hg* at *30 Min*)
3. pO_2- Varied by: - 8.97 to + 12.4% but overall there was a fall of with relative increases seen after *15 min*. Av fall at *30 min*: *2.83 mm Hg*.
4. Bicarbonate- Varied by: - 6.51 to + 13.66% (↑ *0.45–0.71 mmol/lt*)- highest changes were seen bet. *15 Min* and *30 min*. Statistically not significant.
5. BE Statistically not significant at all times (± *0.028 mmol/lt*)
6. O_2 content No change up to *15 min*., then

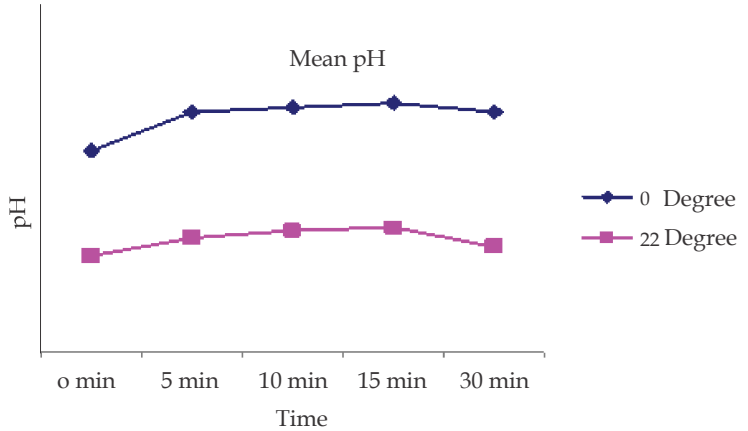

Fig. 1: pH Changes over time at 0°C & 22°C

changed marginally (-2.54 to + 1.5%) (↓*0.136 ml%)*

7. CO_2 content Trend of fall seen after *15 Min*, persisting till *30 min* (–7.8 to + 13.6%)

Discussion

ABG analysis is useful in critically ill patients:

- Standard ABG analyzers are costly to buy

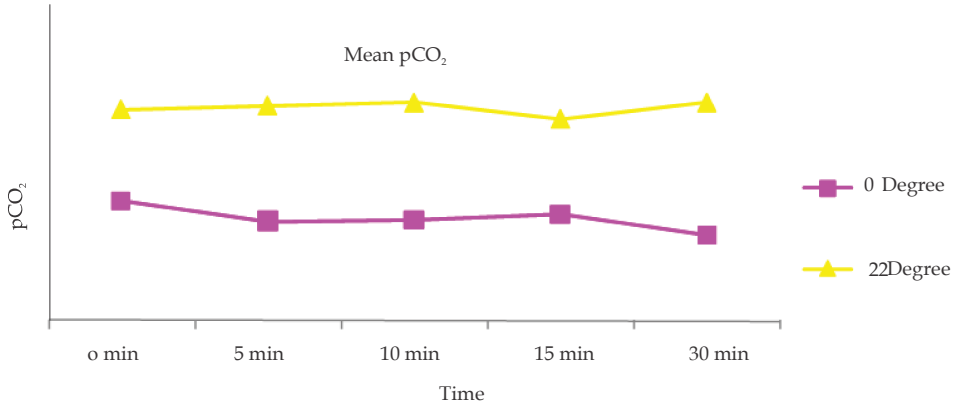

Fig. 2: pCO2 Changes over time at 0°C & 22°C

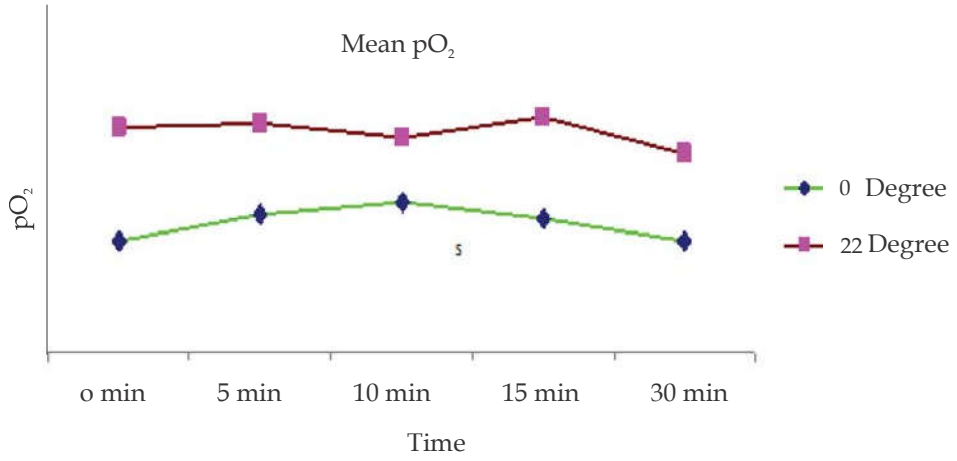

Fig. 3: pO2 Changes over time at 0°C & 22°C

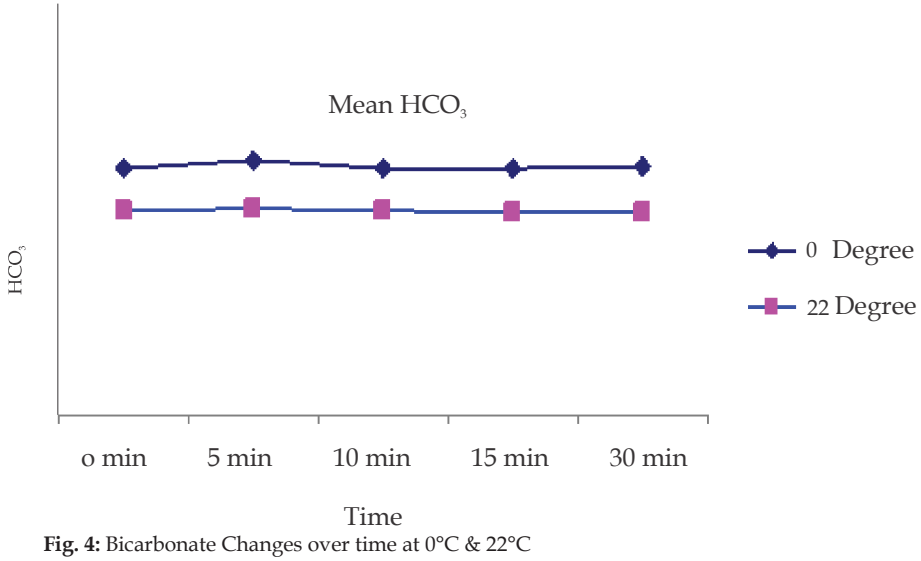

Fig. 4: Bicarbonate Changes over time at 0°C & 22°C

Table 1: Average results of all parameters at 0^0 and 22^0 C with respect to Time

Parameter	Av. Changes 0 to 30 min			
	0°C	Remarks	22°C	Remarks
pH	↓0.015	Stable	↓0.024	↓15th Min
pCO_2 (mm Hg)	↑ 0.08	Stable	↑ 2.1	Small ↓ 15th Min
pO_2 (mm Hg)	↓ 2.03	Stable	↓2.83	Small ↑ 15th Min
HCO_3 (mmol /lt)	±0.029	Stable	±0.631	Changes highest after 15th Min
B E (mmol / l)	±0.018	Stable	±0.028	Stable
CtO_2 (ml%)	↓0.129	Stable	↓0.136	After 15th Min
$CtCO_2$ (ml%)	↓0.421	Stable	↓0.7	After 15th Min

(> Rs 4 lacs) and costly to maintain (*min*. 15,000 for *45 days* for solutions);

- A single machine in a hospital may cater to large number of patients, probably with waiting list and delayed analysis;

Delay in analysis can cause the following changes:

Reduce pH[1]: Anaerobic glycolysis by RBCs, WBCs, Reticulocytes leads to production of organic acids. Fall in pO_2[2] with corresponding smaller changes in plasma Bicarbonate and pCO_2: because of continued blood buffering.

These changes with time can be minimized by:

(a) Can be minimized by reducing the temperature of blood;

(b) Cooling reduces rate of metabolism of cells[1,2];

(c) Immersing in ice (*0°C*) will preserve the cells better than storage at any other temperature[5–7];

There is a 'tendency to hurry through' the various steps in ABG analysis, Hence, we studies changes in the ABG values at different intervals after withdrawal, at *0°C* and *22°C* and found that results shows in **Table 1**.

Conclusion

It is best to analyze the sample anaerobically immediately or within *15 min*, at both *0°C* and *22°C*. If there is possibility of delay up to *30 min*, the sample may be stored ideally at *0°C*, as storage at *22°C* is associated with changes (albeit in-significant statistically) after *15 min*.

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