

(5) CORRELATION OF END TIDAL CARBON DIOXIDE WITH ARTERIAL CARBON DIOXIDE DURING CARDIOPULMONARY BYPASS.

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ABSTRACT :

INTRODUCTION : Optimal blood gas management is subjected to pH- and alpha- state during hypothermia; Alpha state managed by maintaining constant total carbon dioxide stores during cardiopulmonary bypass (CPB) changes thermodynamic dissociation with change in temperature. pH remains constant during temperature changes. A correlation between end tidal carbon dioxide and arterial PCO₂ known to be a non- invasive and safe procedure in patients undergoing Coronary artery bypass graft.

PATIENTS AND METHODS : Forty patients were maintained with normothermia and hypothermia during cardiac surgery in the current study. All patients were operated with midline sternotomy, aortic bicaval cannulation or aortic-right atrium cannulation for cardiopulmonary bypass. Arterial Blood Gas measurements (ABG) along with ETCO₂ and PaCO₂ monitoring were performed.

RESULTS: The patient group had undergone a variety of surgical procedures (viz. Coronary artery bypass grafting, Replacement of mitral- or aortic- valve or double valve). They were maintained on CPB with aorta cross clamp. There was no significant difference in ETCO₂ and PaCO₂ pressures both at normothermia as well as moderate hypothermia during CPB.

CONCLUSION: Monitoring ETCO₂ reflects accurate measurements of PaCO₂. Repeated sampling for ABG therefore can be avoided as a cheap, non-invasive method to ascertain the health of the patients.

KEYWORD : Cardiopulmonary Bypass, End Tidal Carbon Dioxide (ETCO₂), ABG

INTRODUCTION :

Optimal blood gas management during deliberate hypothermia has been subject of intense debate. (1-3) pH state and alpha state approaches have been advocated. The net charge (dissociation) of proteins remains constant as the temperature changes in acid–base management strategy during alpha state.

This is managed by maintaining constant total CO₂ stores during CPB that allow pH and PaCO₂ to follow their thermodynamically mediated dissociation changes with change in the temperature. Exogenous CO₂ therefore is not added to the system during cooling. In pH state management, the constant pH value is sustained at varying temperatures. Exogenous CO₂ is added in this method while the blood is cold; this would maintain a PaCO₂ at 40 and pH at 7.4. Total CO₂ stores thus are elevated. (4)

Several studies have observed no difference in the outcome with either of these strategies. Alpha state is easy to manage and has additional advantages compared to pH state. Almost all centers therefore follow alpha state management strategy (5-6).

Measuring end tidal carbon dioxide (ETCO₂) reflects adequacy of circulatory system and metabolism (7). A correlation between ETCO₂ and arterial PCO₂ (paCO₂) during deep hypothermia and pH state management has been documented. (8) ETCO₂ and PCO₂ measurements have been documented as a non-invasive and safe procedure for healthy patients undergoing coronary artery bypass graft. (9)

The aim of this study was to find out the correlation between ETCO₂ and paCO₂ during moderate hypothermia and alpha state management during Cardio Pulmonary Bypass (CPB).

MATERIAL AND METHOD :

Eighty patients undergoing cardiac surgery with cardiopulmonary bypass and moderate hypothermia during November 2012 to January 2013 at U. N. Mehta Institute of Cardiology & Research Center after obtaining institutional Ethics Committee were included in this study. Patients with COPD (Chronic Obstructive Pulmonary Disease), hematological disorders, concomitant surgery, patients with >70 years age and patients undergoing reoperation surgery were excluded from the study. ETCO₂ was monitored continuously with Primus (Dräger, Germany) connected to membrane gas outlet port during cardiopulmonary bypass. Nipro vital membrane oxygenator was used for all the patients. These patients were divided into two groups; each with similar number of patients. The patients were maintained either at normothermia at (37⁰C) or managed with moderate hypothermia (28⁰C) during the CPB. Arterial Blood Gas (ABG) was measured at (i) induction, (ii) immediately after CPB, (iii) after cross clamp and cardioplegia and (iv) every 30 minutes thereafter to look for pH, PaO₂, PaCO₂, hematocrit and electrolytes. ABG was also measured after protamine and before closer of the chest to check for hemostasis. Arterial Blood Gas was measured with model Stat Profile pHox Plus C (Nova Biomedical, USA).

All patients operated with midline sternotomy and aortic and bicaval cannulation or aortic and right atrium cannulation for CPB. All the patients were operated with moderate hypothermia (up to 28 degree). All patients were operated by single team of surgeon, anesthetist and perfusionist.

STATISTICS:

The statistical analysis was performed with IBM SPSS version 20. All continuous variables were presented as Mean \pm SD and categorical variables were expressed as percentages.

RESULTS:

Majority of patients were males and a mean age of 45 years. They were from a variety of surgical procedures viz. CABG (25%), Mitral valve Replacement (MVR; 37.5%), Aortic Valve replacement (AVR; 22.5%) and Double valve Replacement (DVR; 15%; Table -1). They were maintained on Cardiopulmonary Bypass (CPB) for a mean of 92 minutes. The Aorta Cross Clamp (ACC) time was for a mean of 66 minutes.

End Tidal CO₂ (as mm Hg) and partial pressure of CO₂ in arterial blood (PaCO₂; as mm Hg) were similar between the patients maintained either with normothermia (37⁰C) or at moderate hypothermia (28⁰C) announcing the utility of ETCO₂ as surrogate of PaCO₂ (Fig.-1).

DISCUSSION:

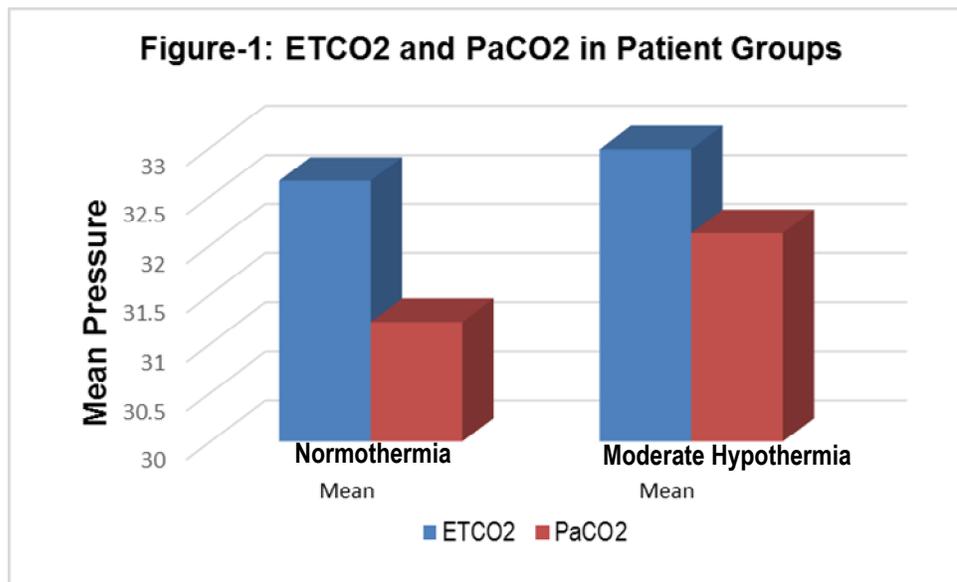
Arterial blood gas estimation provides an accurate information of patient's well-being. Alternatively, non-invasive methods like pulse oximetry and ETCO₂ can also be used effectively. ETCO₂ monitoring is used to estimate arterial PaCO₂. (10) In healthy subjects, a close correlation exists between PaCO₂ and ETCO₂. It is accepted that PaCO₂ measurements remains 2 to 5 mg higher than ETCO₂. (11)

Measurement of ETCO₂ has been identified as valuable tool to monitor airway patency and confirms endotracheal intubation and can be used to guide ventilation as a surrogate measure of PaCO₂. (12) ETCO₂ measurements are found to be sufficient to monitor PaCO₂ in patients with trauma, brain injury, respiratory failure and obviates the need for repeated arterial blood gas determination (13-14).

Our results demonstrated no significant differences between ETCO₂ and PaCO₂ during cardiopulmonary bypass with moderate hypothermia and alpha state management for blood gases. Monitoring ETCO₂ reflects almost accurate measurements of PaCO₂. Repeated sampling for ABG can thus be avoided. This finding is consistent with other studies. (15) Studies with large number of patients is warranted to establish the utility of this non-invasive, less expensive method to ascertain the wellbeing of the patients undergoing cardiac surgery with cardiopulmonary bypass and moderate hypothermia.

Table – 1: Patient Characteristics

Age (Years; Mean \pmSD)	45.74 \pm 15.68
Male (Number; %)	52 (65%)
Female (Number; %)	28 (35%)
Type of Surgery	
• CABG (Number; %)	20 (25.0%)
• MVR (Number; %)	30 (37.5%)
• AVR (Number; %)	18 (22.5%)
• DVR (Number; %)	12 (15.0%)
CPB Minutes (Mean \pm SD)	92 \pm 38
ACC Minutes (Mean \pm SD)	66 \pm 28

Figure-1 is with Legend**REFERENCES :**

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