Elimination of Gaseous Microemboli from Cardiopulmonary Bypass using a Veno-arterial Shunt

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INTRODUCTION

Surgeries requiring cardiopulmonary bypass are frequently complicated by neurocognitive deficits. Leading potential contributors to these deficits are gaseous microemboli (GME) which are introduced into the patient's arterial blood despite filtration. Traditional cardiopulmonary bypass oxygenators use a sweep gas containing an oxygen/nitrogen mixture in order to control oxygen partial pressure. We believe that use of nitrogen is both unnecessary and potentially harmful due to its effects on GME formation and reabsorption.

Here, a venous-to-arterial shunt was employed in parallel with an oxygenator using pure oxygen sweep gas to achieve desirable arterial blood gases in the absence of nitrogen. We assessed the practicality of this approach for blood gas management and GME removal in the laboratory in order to facilitate the study of GME removal and cognitive outcomes in cardiac surgery patients.

METHODS

We used a cardiopulmonary bypass circuit with a simulated patient and included a veno-arterial shunt with or without filtration device. EDAC were used to monitor number and size of GME. These EDAC locations were monitored during 3 different conditions; a control condition in which there was no veno-arterial shunt and 100% of the blood passed through the oxygenator, a shunted condition in which the blood was shunted through a limb without a filter, and a filtered shunt condition in which the blood was shunted through a limb with an arterial filter. Blood samples were taken downstream of the patient simulator and at the arterial line filter.

RESULTS

The use of a veno-arterial shunt reduced GME delivery from the cardiopulmonary bypass circuit while providing desirable oxygenation and ventilation conditions. The difference in GME delivery was greatest when a filtration device was included in the shunt limb. The undersaturation of blood with dissolved oxygen and carbon dioxide in the absence of nitrogen facilitates the reabsorption of GME into the blood phase.

CONCLUSION

Veno-arterial shunting appears to be a practical and effective strategy to minimize GME exposure to patients undergoing cardiopulmonary bypass. This technique holds promise for reducing GME delivery compared to current technology and may facilitate study of the role of GME in cognitive outcomes following cardiac surgery.