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Case Report

Use of Volatile Anesthetic Agent in Extracorporeal Circuit as a Cause of Break in Polycarbonate Connector–Lessons Learnt

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Abstract: Mishaps, near misses, and lethal incidents are known to occur during cardiopulmonary bypass. We share one such rare case of break in polycarbonate connector because of the use of isoflurane in extracorporeal circuit and its successful management. **Keywords:** cardiopulmonary bypass, polycarbonate, isoflurane, atrial septal defect. *J Extra Corpor Technol. 2017;49:198–200*

Cardiopulmonary bypass (CPB) has undergone many improvements since its first attempt to permit intracardiac surgery in humans at the University of Minnesota Hospital by Dennis et al. (1) on April 5, 1951. These improvements have not come without complications. Some equipment failures and technical errors during CPB can be life threatening in some cases. During CPB, volatile anesthetics are generally administered through the oxygen inlet line using an anesthetic vaporizer to augment the level of sedation and control the blood pressure. However, volatile anesthetics are known to have an adverse physicochemical effect on polycarbonates (2). There are reports of damaged plastic anesthetic equipment and other medical devices (3–7), particularly, damaged CPB parts made from polycarbonate, such as membrane oxygenators (6,7). Some literature indicates that plasticizer molecules in the polyvinyl chloride (PVC) tubing can be displaced by anesthetic agent molecules (8), which is a slow process if the gas line tubing is exposed only to sweep gas flow vapors, but the reaction is accelerated if the concentrated anesthetic solution accidentally comes in contact with the PVC material. We share here such an incident which was successfully managed and provide tips to avoid such mishaps during the conduct of CPB.

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CASE PRESENTATION

A 30-year-old male (body surface area 1.52) with no comorbidities was admitted for surgical closure of an atrial septal defect (ASD). After the induction of anesthesia with thiopentone, isoflurane, and morphine sulfate, the surgery was performed through midline sternotomy, and CPB (3.6 L/min) was established with aortic and bicaval cannulation. After arresting the heart with antegrade cold blood cardioplegia, under moderate hypothermia (30°C), the right atrium was opened to prepare for closure of the ASD. As the surgeon was suturing the pericardial patch in place to close the ASD, there was a sudden change in color of the arterial line from bright red to a dark color. On checking the circuit, the perfusionist noted a disconnection of the gas inlet line from the oxygenator membrane housing (Capiox SX 18R, Figure 1). The problem was immediately picked up by the perfusionist and communication was made to the anesthetist and the surgeon. Because of an anticipated short CPB duration and the fact that manually holding the gas input connector (1/4 inch) onto the oxygenator increased FiO2–100% at a gas flow of 4 L/min, further

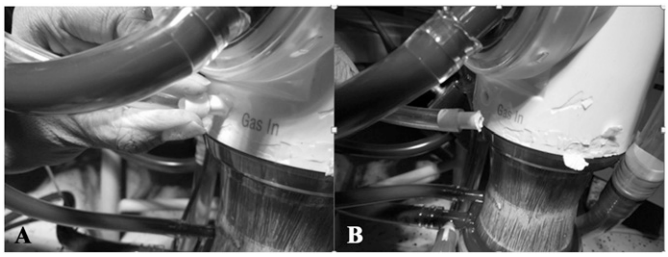

Figure 1. (A) Handholding of disconnected oxygen inlet line. (B) Reaction of isoflurane with polyvinyl chloride with disconnected gas inlet line.

cooling of the patient and replacement of the oxygenator was not attempted.

Periodic arterial blood gas analysis showed no hypoxia or acidosis occurred during the incident (Table 1). Once the cross clamp was released, mechanical ventilation was resumed, and there was no fall in saturations or increase in ETCO2 (end tidal carbon di oxide) noted. The patient was separated from CPB and transferred to intensive care unit (ICU) with stable hemodynamics. The total cross clamp time was 15 minutes, and the total CPB time was 40 minutes. The patient recovered consciousness 4 hours after arriving in the ICU and was extubated 6 hours after surgery. He was discharged on 3rd postoperative day with no sequelae.

After a careful review of the incident, it was found that the most likely cause of the fractured gas inlet connector was exposure of the inlet to liquid isoflurane during filling of the vaporizer.

After this incident, the isoflurane vaporizer was moved to an alternate location on the heart–lung machine to prevent a similar incident from occurring again.

DISCUSSION

According to a survey of reported CPB cases between 1996 and 1998 by Mejak et al. (9), a CPB incident occurs once every 138 cases (.7%). A fracture of the break in polycarbonate connector on the membrane oxygenator is a very rare incident that could significantly impact patient outcomes.

In heart–lung bypass procedures, external circuits provide oxygenation and filtration of the blood as a temporary means to support the patient's normal circulatory and pulmonary function. One strategy to maintain the level of anesthesia and blood pressure during CPB is to attach an anesthetic vaporizer on the circuit to infuse a vaporized halogenated anesthetic agent with a fresh gas flow to the oxygenator.

Reports indicate that plasticizer in the PVC tubing can be displaced by the anesthetic agent molecules (8). This process is slow if the gas line tubing is exposed only to sweep gas flow vapors, but the reaction is accelerated if the concentrated anesthetic solution accidentally comes in contact with PVC material. Under normal conditions, the plasticizer leaches from the tubing, and the tubing becomes stiff and can crack over time. An oily material, primarily the di (2-ethylhexyl) phthalate plasticizer, collects inside the tubing. Although PVC is the most commonly used plastic tubing for heart–lung bypass circuits, plasticizers in the oxygenator housing may also be soluble in halogenated anesthetic agents and may exhibit the same problem as PVC tubing over prolonged periods of exposure.

In our case, while filling the isoflurane vaporizer by the perfusionist, some of the isoflurane liquid came in contact with the PVC gas connector which led to melting of the connector and its disconnection from the oxygenator at the inlet site. It was concluded that some liquid isoflurane accidently spilled from the vaporizer because of vigorous shaking of the container. There was no blood leak from the oxygenator, so the situation was managed by manually holding the inlet line to the oxygenator.

CONCLUSION

While administering anesthetic gases such as isoflurane, the vaporizer should not be located anywhere near the membrane oxygenator or extracorporeal tubing. Timely recognition and management of the mishap during this case was lifesaving. This case highlights the need for clinicians to be alert to the physicochemical effects of volatile anesthetics on polycarbonates and take preventative measures to isolate anesthetic vaporizers away from the extracorporeal circuit at all times.

CONSENT

Written informed consent was obtained from the patient for publication of this case report and any accompanying

Table 1. Showing arterial blood gas analysis during the conduct and after CPB.

Arterial Blood Gas Analysis	FiO2 (%)	pH	pCO2 (mmHg)	pO2 (mmHg)	HCO3 (mmol/L)	BE (mmol/L)	Hb (gm%)	Hct	O2 Sat(%)
As soon as problem was detected	100	7.29	59.3	143	28	0.6	12.3	33.7	100
10 minute later	100	7.41	38.7	502	24.4	0.1	12.6	32.7	99.2
After CPB	100	7.45	32.5	234.6	22.1	−1.0	12.7	33.2	99.8

images. Hospital ethical committee approval was obtained for publishing the case report.

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