

Isoflurane cracks the polycarbonate connector of extra-corporeal circuit

-A case report-

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Cardiopulmonary bypass (CPB) is widely used for cardiac surgery by virtue of its proven safety over the course of its use during the past half century. Even though perfusion is safer, incidents still occur. During the repair of a ventricular-septal defect in an 11-month-old infant, we experienced a critical incident related to the potential hazardous effect of volatile anesthetics on the polycarbonate connector of extra-corporeal circuit. The damage to the polycarbonate connector had occurred after spillage of isoflurane during the filling of the vaporizer, causing it to crack and leak. The incident was managed by replacement of the cracked connector during a temporary circulatory arrest. The patient was hypothermic and the time off bypass was less than 1.5 min. There were no neurologic sequelae, the patient made an uneventful recovery. In conclusion, the spillage of volatile anesthetics can cause cracks in the polycarbonate connector of the extra-corporeal circuit, leading to potentially interruption of CPB. (Korean J Anesthesiol 2010; 58: 304-306)

Key Words: Cardiopulmonary bypass, Isoflurane, Polycarbonate connector.

Cardiopulmonary bypass (CPB) in cardiac surgery is safe and widely used procedure but unpredictable incidents can occur. Problems with the oxygenator, electrical and mechanical failures, air embolisms, and coagulopathy-related complications, which can cause serious damage or even death, have been reported [1-3]. Hence, CPB requires special precautions.

In extra-corporeal circulation by CPB, volatile anesthetics are generally administered in the oxygen inlet line using a vaporizer

to control the blood pressure. However, volatile anesthetics have a physicochemical effect on polycarbonates. There are reports of damaged plastic anesthetic equipment and other medical devices [4-8], particularly damaged CPB parts made from polycarbonate, such as membrane oxygenators [7,8].

This paper reports a case where isoflurane destroyed the polycarbonate connector in CPB equipment during cardiac surgery, resulting in the outlet of blood.

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Case Report

A female patient, 11 months of age and 9.5 kg in weight, was diagnosed with a ventricular septal defect (VSD). She was brought to the OR for a patch closure. She had no medical history or other conditions. There were no strange findings in the preoperative examination. The echocardiogram before surgery revealed a perimembranous trabecular type VSD, 6 mm in size. The left atrium and left ventricle were slightly enlarged.

After anesthetic induction, sufentanil was infused continuously, and isoflurane was administered for anesthetic maintenance. The surgery was uneventful up to this stage. After aortic and venous cannulation, the CPB was initiated. However, 20 minutes into the CPB, drops of blood on the OR floor were observed. After a more careful observation, blood was found to be leaking from the connector (1/4 inch, Bentley, USA) between the membrane oxygenator and arterial filter. The connector was partially cracked, which was considered quite serious. After discussions with the operator, we decided to replace the polycarbonate connector with a new one. At this stage, the esophageal temperature was 24°C, the activated clotting time was 765 seconds, and the arterial blood line pressure was 160–170 mmHg. To minimize the temporary circulatory arrest time, all preparations were performed and checked. Subsequently, both ends of the connector were clamped and quickly replaced with a new one. The total circulatory arrest time was 1.5 min. After the replacement, air was removed, and the CPB was resumed. The surgery was completed with no other complications. The patient was moved to the intensive care unit. The total CPB time was 117 min, and the aortic clamp time was 63 min.

After surgery, the cause of the crack in the connector was traced to the initiation of CPB, when the vaporizer (PPV, Penlon, UK) connected to the membrane oxygenator was filled with isoflurane and droplets of isoflurane fell onto the connector. A test was carried out by dropping a small amount of isoflurane

on a different connector made from the same material and it was observed to deteriorate (Fig. 1). After this incident, the isoflurane vaporizer was then moved to a safer location to prevent a similar incident from occurring again.

One day after surgery, the patient's mental status, respiration and vital signs were normal. Therefore, the endotracheal tube was removed from the patient. With no sequelae, she was discharged on post-operative day-7.

Discussion

CPB was first used in the 1950s. Since then, the safety of CPB has always been a concern. This is because although CPB makes efficient extra-corporeal circulation possible for cardiac surgery, incidents related to CPB can have adverse or fatal effects. According to a survey between 1996 and 1998 by Mejak et al. [9], a CPB incident of the reported cases occurred once every 138 cases (0.7%). The most common occurring incidents were protamine reactions, coagulation problems, and heater/cooler failures. The rate of occurrence of an incident resulting in a serious injury or death was one for every 1,453 procedures (0.07%). Mechanical problems resulting in the interruption of CPB, as in the presented case, occur infrequently [10]. The temporary circulatory arrest time in the present case was about 1.5 min. At the time that the decision was made to replace the connector, the esophageal temperature was 24°C. The replacement was predicted to have few problems and the required time was estimated to be short. Therefore, no special procedures were taken for cerebral protection. However, deep hypothermic circulatory arrest, which is commonly performed for complex congenital heart defects and aortic surgery, and a regimen of steroids and barbiturates must be seriously considered when the time off the bypass is expected to be long. Moreover, attention to hemodilution, arterial blood gas management, and glucose control must be given [11].

In the extra-corporeal circuit, the oxygenator and venous reservoir are usually made from polycarbonate because it is quite safe at high temperatures and is resilient to shock. In addition, it is flexible and clear, so it is often used in injection molding chemical products. Unfortunately, there are many reports of polycarbonate products being destroyed by volatile anesthetics [4-8]. The slightly different levels of damage to the polycarbonates depend on the volatile anesthetics. Maltry and Eggers [7] reported that polycarbonate oxygenators experience cracks due to isoflurane but observed that enflurane had no effect. They also reported that halothane did not cause cracks but made the plastic surface more flexible and bend. We also tested droplets of different types of volatile anesthetics on the polycarbonate connector. Isoflurane caused a small, narrow crack and made it break. Halothane did not create a crack but

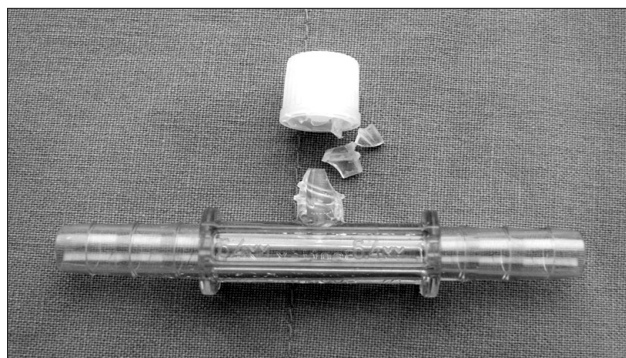


Fig. 1. Cracked and fragmented connector after spillage of isoflurane.

melted the plastic surface. However, enflurane, sevoflurane and desflurane had no effect. This is in contrast to Cooper and Levin [8], who reported that isoflurane, enflurane and halothane caused the polycarbonate oxygenators to break.

Polycarbonate medical equipment and devices are used in many different areas of medicine. In the anesthesia, caution must be taken to prevent the physical effects of volatile anesthetics on polycarbonate. First, plastic products cannot be placed near the vaporizer, particularly below it. After the authors experienced this case, the isoflurane vaporizer was moved where it cannot come in contact with plastic products in any way. Second, in cardiac surgery requiring extra-corporeal circulation, the vaporizer should be checked and filled with volatile anesthetics before setting up the disposable CPB set, such as the oxygenator. Third, anesthesiologists and all other medical staff in the OR should be made aware of the physical effects of volatile anesthetics on plastics.

In conclusion, there was an incident in a cardiac surgery while filling the vaporizer with isoflurane. Spilling drops of isoflurane caused a crack in the polycarbonate connector of the CPB. Consequently, the CPB had to be stopped, and emergency measures were taken. This case highlights the need for anesthesiologists to be alert to the physicochemical effects of volatile anesthetics on polycarbonates.

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