CASE REPORT

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End-tidal carbon dioxide monitoring revealed severe complications during cardiothoracic surgery

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ABSTRACT

Introduction: With the continuous progress being made in medicine and surgery, increasingly more advanced technology and monitoring equipment are being used in anesthesia, end-tidal carbon dioxide ($PETCO_2$) monitoring revealed serious complications of cardiothoracic surgery.

Case presentation: A 3-year-old boy with a body weight of 15 kg presented with a >1-month history of a heart murmur. At the moment of arterial catheter ligation, the $PETCO_2$ decreased from 37 to 15 mmHg, while the blood pressure, heart rate, and airway resistance did not change significantly. After re-separation of the ligation catheter, the surgeons carefully exposed the ductus and left pulmonary artery again and ligated the ductus arteriosus.

Conclusion: This case suggests that $PETCO_2$ monitoring reflects the circulatory status and pulmonary blood flow.

KEYWORDS
End-tidal carbon dioxide, Monitoring, Complications, Cardiothoracic surgery

INTRODUCTION

With the continuous progress being made in medicine and surgery, increasingly more advanced technology and monitoring equipment are being used in anesthesia, allowing anesthesiologists to accurately identify problems in anesthetic management in a timely manner. In the present case, end-tidal carbon dioxide ($PETCO_2$) monitoring revealed serious complications of cardiothoracic surgery. This case provides a warning that clinicians should always pay attention to changes in patients' vital parameters and that the most basic monitoring can reveal problems, helping to ensure the patient's perioperative safety.

CASE REPORT

A 3-year-old boy with a body weight of 15 kg presented with a >1-month history of a heart murmur. He was admitted to the hospital with a diagnosis of patent ductus arteriosus and was scheduled to undergo ductus arteriosus ligation under general anesthesia. The patient was susceptible to respiratory infections, had a slightly low tolerance to physical activity, and had no history of any other relevant diseases. Heart beating and trembling could

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be palpated at precordial area, a grade 4/6 continuous murmur was heard between L_2 and L_3, and the P_2 heart sound was louder than the A_2 heart sound. In the auxiliary examination, a chest radiograph showed a slightly enlarged heart shadow, and cardiac B-scan ultrasound showed a patent ductus arteriosus, a horizontal left-to-right aortic shunt, a split beam width of about 6 mm, no other special circumstances. After the anesthesia machine was connected to the monitor, the patient was anesthetized; 1.5 mg of midazolam, 2 mg of etomidate, 20 μg of remifentanil, and 2 mg of cisatracurium were slowly injected as an intravenous bolus. The left radial artery and central vein were smoothly cannulated after intubation. Maintenance of anesthesia was maintained by continuous administration of propofol at 4–10 mg/(kg · h), remifentanil at 10–30 μg/(kg · h), and cisatracurium at 0.15–0.2 mg/(kg · h) via an intravenous pump, and the depth of anesthesia was adjusted according to the degree of surgical stimulation. Before ligature of the ductus arteriosus, the patient's respiratory parameters were relatively stable. With the patient in the right lateral position, a left posterior lateral incision was made through the fourth intercostal space into the pleural cavity. The upper lobe was pushed down to reveal the upper mediastinum, and the left phrenic nerve, vagus nerve, left subclavian artery, descending aortic arch, left pulmonary artery, and arterial catheter were identified. The ductus was enlarged. At the moment of arterial catheter ligation, the $PETCO_2$ decreased from 37 to 15 mmHg, while the blood pressure, heart rate, and airway resistance did not change significantly. We considered the fact that during this operation, it is possible to mistakenly ligate the left pulmonary artery instead of the ductus. Arterial blood gas analysis and intraoperative esophageal ultrasonography were performed. The blood gas analysis results showed that the partial pressure of carbon dioxide in artery ($PaCO_2$) had increased from the 35 mmHg at baseline to 60 mmHg, and esophageal ultrasound confirmed that the left-to-right aortic shunt was still present. After re-separation of the ligation catheter, the surgeons carefully exposed the ductus and left pulmonary artery again and ligated the ductus arteriosus. $PETCO_2$ did not decrease significantly, and all monitoring parameters remained stable until the end of the operation. The patient was discharged from the hospital 7 days postoperatively. No abnormalities were found after 1 month of follow-up.

DISCUSSION

$PETCO_2$ is an important indicator reflecting metabolism, ventilation, and circulation. It is considered to be one of six basic bodily parameters, the other five being body temperature, respiration, peripheral capillary oxygen saturation, blood pressure, and pulse.[1] As the highest value of carbon dioxide in the respiratory cycle, $PETCO_2$ is generally considered to represent the partial pressure of alveolar carbon dioxide. Because of the strong dispersion ability of carbon dioxide, the partial pressure of alveolar carbon dioxide is close to that of $PaCO_2$. Therefore, measurement of $PETCO_2$ is performed to estimate the $PaCO_2$ value in the clinical setting. $PETCO_2$ is used to monitor the ventilatory status and reflects the circulatory function and pulmonary blood flow.[2] In the case of constant ventilatory function, the decrease is often seen in the reduction of cardiac output, such as in patients with hypotension, hypovolemia, shock, and heart failure. As the pulmonary blood flow decreases, $PETCO_2$ gradually decreases. At the time of cardiac arrest, $PETCO_2$ drops sharply to zero.[3]

$PETCO_2$ suddenly decreases in patients with pulmonary embolism, and when the arterial catheter is ligated, $PETCO_2$ drops significantly while other parameters remain relatively constant. Combined with the special anatomical position of the arterial catheter, the risk of erroneously occluding one side of the pulmonary artery is suspected to be high because the very rapid decrease of $PETCO_2$ indicates a decrease in pulmonary blood flow, resulting in an imbalance in the ventilation-to-blood flow ratio when ventilation parameters are constant and other circulatory indexes are relatively stable. Thus, the decrease in $PETCO_2$ is accompanied by an increase in $PaCO_2$. The left pulmonary artery was mistakenly ligated as confirmed by transesophageal echocardiography, and the patient was discharged after re-separation of the ligated ductus arteriosus.

The most serious complications in cardiothoracic surgery can be found by the most basic $PETCO_2$ monitoring, which can ensure patients' safety during the perioperative period. This case suggests that $PETCO_2$ monitoring reflects not only respiratory function but also the circulatory status and pulmonary blood flow more quickly and accurately than ultrasound.

CONFLICT OF INTEREST

We have read and understood the *Pediatric Investigation* policy on the declaration of interests and declare no competing interests.

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