



Oxygen-Associated Hypercapnia after both side Video-Assisted Thoracoscopic Surgery - A Case Report

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Summary

Thoracoscopy, as a minimally invasive surgical technique in the field of thoracic surgery, has been widely utilized due to its minimally invasive nature, cost-effectiveness, and short hospital stay. Most thoracoscopic surgeries involve intraoperative single-lung ventilation, aiming to maintain intraoperative oxygen saturation (SPO₂) above 93% by increasing the respiratory rate and administering a high concentration of oxygen. However, the high concentration of oxygen administered during surgery and postoperative pain in thoracic surgery often result in decreased ventilation and hypoxia in patients. This case report details a patient who underwent bilateral thoracoscopic surgery with single-lung ventilation on both sides, subsequently developing oxygen-associated hypercapnia in the post-anesthesia care unit (PACU) and necessitating reintubation.

Keywords

Video-Assisted Thoracoscopic Surgery, Hypercapnia, Carbon Dioxide Narcosis, Reintubation

Case Presentation

The patient is a 43-year-old male with a height of 165cm, weight of 65kg, and BMI of 23.88kg/m². He underwent elective thoracoscopic resection of bilateral lung nodules under general anesthesia. The patient had concomitant bilateral renal cysts, hepatic hemangioma, hepatic cysts, and right renal calculi. Other preoperative examination results were unremarkable. The patient had no history of asthma, smoking, chronic obstructive pulmonary disease, or symptoms of upper respiratory tract infection.

Anesthesia induction was performed using sufentanil 25ug, cisatracurium 15mg, propofol 100mg, and midazolam 2mg. A 35F left double-lumen endotracheal tube was smoothly inserted to a depth of

30cm after good bilateral lung isolation was auscultated. The surgery started with the patient in the left lateral position, and right lower lobectomy was performed. Then the patient was turned to the right lateral position for left lower lobectomy. Sevoflurane, remifentanyl, and propofol were continuously infused during the surgery, with intermittent administration of sufentanil and cisatracurium to maintain anesthesia. The surgery proceeded smoothly with a duration of 4.5 hours.

At the end of each side of the surgery, intercostal nerve block was performed by the surgeon under direct visualization for postoperative analgesia. During the surgical anesthesia, a total of 45ug of sufentanil and 26mg of cisatracurium were used (last

administration was approximately 2 hours before the patient's initial awakening and extubation).

After the surgery, the patient was transported to the post-anesthesia care unit (PACU) with the endotracheal tube in place, waiting for the patient to wake up. Upon entering the PACU, the heart rate was 100 beats per minute, oxygen saturation (SPO₂) was 99% (mechanical ventilation, respiratory rate of 14 breaths per minute, tidal volume of 450ml, oxygen concentration of 50%), blood pressure (BP) was 113/87mmHg, and ETCO₂ was 51mmHg. Due to the patient experiencing chills, 50mg of tramadol was administered intravenously, and a warming blanket was applied.

After 21 minutes in the PACU, the patient regained consciousness, and the anesthesiologist removed the endotracheal tube at the bedside. Nasal cannula oxygen at 3L/min was provided, and the modified Aldrete score was assessed with a score of 6 (consciousness: 1 point, respiration: 1 point, circulation: 2 points, oxygenation: 1 point, activity: 1 point, lip color: 2 points). Ten minutes after extubation, the patient became restless and complained of pain, and was given a 5ug intravenous injection of sufentanil.

Fifteen minutes after extubation, the patient experienced tongue prolapse, and a nasopharyngeal airway was inserted to continue nasal cannula oxygen at 3L/min. Twenty minutes after extubation, the patient's heart rate increased to 124-134 beats per minute, and he became agitated and sweaty. The anesthesiologist performed bedside ultrasound examination and found no abnormalities. When called, the patient was found to have loss of consciousness, and SPO₂ decreased from 99% to 95%. Immediate examination of ETCO₂ (my medical facility does not have transcutaneous carbon dioxide monitoring tools available in a short period of time) revealed a level as high as 66mmHg. Blood gas analysis performed at the same time showed a pH of 7.123, PCO₂ of 99mmHg, PO₂ of 103.5mmHg, and BE of -0.12.

Forty-five minutes after extubation, the modified Aldrete score was assessed with a score of 5 (consciousness: 1 point, respiration: 1 point,

circulation: 2 points, oxygenation: 1 point, activity: 0 points, lip color: 2 points), suggesting the patient had developed hypercapnia and carbon dioxide narcosis. Fifty-six minutes after extubation, the patient was reintubated with a 7.5F single-lumen endotracheal tube after receiving 40mg of rocuronium and 70mg of propofol intravenously.

After communicating with the surgeon, the patient was transferred to the ICU for further monitoring. After admission to the ICU, the endotracheal tube was removed on the same day of surgery, and blood gas analysis showed a pH of 7.375, PCO₂ of 37.1mmHg, PO₂ of 201.5mmHg, and BE of -3.5mol/L. The patient was transferred back to the general ward on the second day after surgery and was discharged smoothly on the fifth day after surgery.

Discussion

Thoracoscopy, a widely utilized minimally invasive surgery in thoracic surgery, is chosen for its minimally invasive nature, cost-effectiveness, and shorter hospital stay. However, due to the potential impact of postoperative pulmonary complications (PPCs), simultaneous bilateral thoracoscopic surgery is less common, and it demands higher analgesic requirements. While studies [1, 2] suggest that intercostal nerve block (ICNB) can offer simple and effective acute postoperative pain management in thoracoscopic surgery, our case suggests that a multimodal analgesic approach [3], incorporating preoperative and postoperative continuous use of acetaminophen + NSAIDs, combined with bilateral paravertebral nerve block or thoracic epidural analgesia during surgery, may be preferable for patients undergoing simultaneous bilateral thoracoscopic surgery.

The patient in this case experienced sinus tachycardia and a gradual increase in heart rate, peaking at 134 beats per minute, during the PACU observation period. This warrants serious attention. Unfortunately, we did not further analyze this abnormal indicator at the time, attributing the increased heart rate to pain and elevated body temperature. This oversight masked the early detection of hypercapnic acidosis, resulting in carbon

dioxide anesthesia. While postoperative abnormal heart rate fluctuations are common in thoracic surgery [4,5], we emphasize the need for vigilance and further monitoring, such as blood gas analysis, ETCO_2 , and transcutaneous carbon dioxide monitoring. Particularly when pain relief does not correspond with a decreasing heart rate, a systematic investigation of possible contributing factors is essential.

Throughout the surgery and PACU recovery period, the patient's target oxygen saturation (SPO_2) was set at $>95\%$, with oxygen concentration adjusted to 33% for nasal cannula and 50% for the endotracheal tube. The lowest recorded SPO_2 was 93%, occurring between the detection of hypercapnia and reintubation. However, the patient's blood gas analysis showed a high PCO_2 level of 99.9mmHg. This may be associated with postoperative pain after bilateral thoracic surgery, continuous inhalation of high oxygen concentration ($>33\%$), and inappropriate use of sedative drugs. In patients undergoing bilateral thoracic surgery, the use of oxygen concentration $>50\%$ during surgery can lead to hypoxic pulmonary vasoconstriction and absorption atelectasis, resulting in an increase in dead space. Pain and continuous oxygen inhalation are primary contributors to the loss of hypoxic pulmonary vasoconstriction, ventilation/perfusion mismatch, and an increase in PaCO_2 levels [6,7]. Therefore, for these patients, a shift in the ventilation strategy during the recovery period from a target oxygen saturation (SPO_2) of $>95\%$ to controlled oxygen therapy that corrects hypoxemia and prevents oxygen-induced hypercapnia is recommended. Thorough evaluation and additional monitoring, including blood gas analysis, nasal ETCO_2 monitoring, and transcutaneous CO_2 monitoring, should be conducted, with a maximum interval of 60 minutes between each measurement [8].

Tips

- SPO_2 should not be considered as the sole indicator for assessing respiratory distress, particularly when oxygen therapy is administered. Additional ventilation parameters, such as ETCO_2 , blood gas analysis, and transcutaneous CO_2 monitoring, should be considered for a comprehensive evaluation.

- It is advisable to monitor additional ventilation parameters in patients at high risk of postoperative ventilation disorders. Regular assessments, including ETCO_2 , blood gas analysis, and transcutaneous CO_2 monitoring, should be performed at intervals not exceeding 60 minutes to promptly identify and address any respiratory complications.

Conflict of Interest

The author has read and approved the final version of the manuscript. The author has no conflicts of interest to declare.

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