Anesthetic Management of Pleurectomy/Decortication Under Differential Lung Ventilation

HIROKO KIMURA, TERUYUKI HIRAKI, SAYO ARATA AND KAZUO USHIJIMA

Department of Anesthesiology, Kurume University School of Medicine, Kurume 830-0011, Japan

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Summary: A 64-year-old male (a building demolition worker) was diagnosed with malignant left-sided pleural mesothelioma, and left-sided pleurectomy/decortication was scheduled. Differential lung ventilation (DLV) was performed during the removal of the visceral pleura by connecting the affected lung to a ventilator and the healthy lung to an anesthesia machine, and then separately ventilating the left and right lungs. Anesthetic management using DLV was successfully established without causing significant changes in oxygenation or circulatory dynamics.

Key words differential lung ventilation, pleurectomy/decortication, malignant pleural mesothelioma

INTRODUCTION

Total resection of the parietal and visceral pleurae is often performed to treat malignant pleural mesothelioma. Ensuring an appropriate level of ventilation is particularly difficult during decortication of the visceral pleura due to gas leakage from the affected lung. Differential lung ventilation (DLV), which involves separate ventilation of the left and right lungs using two ventilators, has been employed in some cases where a single lung was predominantly affected by lesions [1]. However, there have not been any reports about the utility of combining DLV with visceral pleurectomy/decortication to treat malignant pleural mesothelioma.

CASE REPORT

The patient was a 64-year-old male (a building demolition worker; height: 166 cm, weight: 68 kg). The patient had diabetes mellitus, which was being treated with insulin. Pleural effusion was identified on a chest X-ray during a medical checkup, and a thoracoscopic pleural biopsy was performed. The patient was diagnosed with malignant left pleural mesothelioma, and left pleurectomy/decortication was scheduled. Mild restrictive impairment was diagnosed based on preoperative respiratory function testing, which indicated that the patient had a vital capacity (VC) of 2.55 L and a %VC of 74.6%. Ensuring an appropriate degree of ventilation is particularly difficult during decortication of the visceral pleura due to gas leakage from the affected lung. Therefore, we planned to employ separate ventilation of the left and right lungs using two ventilators. Also, we planned to induce general anesthesia using desflurane to avoid delayed emergence, because the operation was expected to last >10 hours. In addition, >1,000 mL of intraoperative bleeding was expected, so a continuous arterial pressure-based cardiac output monitor (FloTrac/Vigileo™; Edwards Lifesciences, Irvine, CA, USA) was used to monitor the patient’s hemodynamic parameters.

After inserting an epidural catheter at T6-7, anesthesia was induced via the intravenous injection of propofol (100 mg), rocuronium (50 mg), and remifentanil (0.2 mcg/kg/min). The patient was intubated using a 37 Fr double-lumen endobronchial tube, left...
(Portex Blue Line®, Smiths Medical Japan, Tokyo, Japan). A cannula for measuring invasive arterial pressure was inserted into the right radial artery, and the patient was placed in the right lateral decubitus position. Anesthesia was maintained via the inhalation of oxygen (1 L/min), air (1 L/min), and desflurane (5%) and the intravenous administration of remifentanil (0.1-0.35 mcg/kg/min). One-lung ventilation of the right lung was performed during decortication of the parietal pleura. In order to reduce the amount of bleeding, the patient’s systolic blood pressure was maintained at 80-100 torr.

During the visceral pleural decortication procedure, the lumen that led to the affected lung was connected to a ventilator (Puritan Bennett™ 840; Medtronic, Tokyo, Japan), and the lumen that led to the healthy lung was connected to an anesthesia machine. Inhalation anesthesia was only administered to the healthy lung. The initial ventilation settings for both ventilators were 60% inspired oxygen, pressure-limited 15 cm H2O, and a ventilation rate of 11 /min. We then decreased the inspired oxygen concentration of the affected lung to 30% to prevent the occurrence of fires in the operating field during the use of electrocautery devices. Since the inflation of the affected lung decreased as gas leakage increased, the pressure settings on the ventilator connected to the affected lung were changed to adjust the degree of inflation as requested by the surgeon (10-20 cmH2O). Throughout the operating procedure the inspiratory and expiratory desflurane concentrations remained stable at approximately 5.5% and 5.0%, respectively.

There were no major changes in oxygenation (SpO2: 100%) or circulatory dynamics (cardiac output: 4.5-4.7 L/min) during the DLV. We transfused 4 units of packed red blood cells when the amount of intraoperative blood loss reached 1,100 g. The operative time was 10 h and 52 min, the anesthetic duration was 12 h and 40 min, and intraoperative blood loss totaled 1,318 mL. After the operation, the patient’s tidal volume during spontaneous breathing was 7 mL/kg. The bronchial tube was extubated following the administration of sugammadex (140 mg). No problems were encountered during the waking of the patient, and he exhibited favorable post-extubation respiratory parameters (breathing rate: 12 /min, SpO2: 100%).

**DISCUSSION**

We successfully established DLV during visceral pleural decortication for malignant pleural mesothelioma without causing any significant complications. To facilitate surgical procedures such as visceral pleural decortication it is necessary to inflate the affected lung to an appropriate degree without collapse because gas leakage from the lung makes it easier to identify the layer between the visceral pleura and lung. Therefore, ensuring an appropriate degree of ventilation can lead to difficulties if it causes large leaks. Furthermore, if gas leakages from the lung contain a high concentration of oxygen, electrocautery devices can ignite fires in the operating field during the procedure. In the present case, because the respective ventilation conditions for the left and right lungs were freely adjustable due to the use of an anesthesia machine and a ventilator, the ventilation settings could be finely adjusted as the surgery progressed. Although adequate oxygen can be delivered to the lung using continuous positive airway pressure therapy or a Jackson Rees circuit, we ventilated not only the healthy lung, but also the affected lung, in order to inflate the affected lung to an appropriate degree and control its inspiratory oxygen concentration.

To prevent the leakage of the inhaled anesthetic from the operative field, inhalation anesthetic was only administered to the healthy lung. There are currently no reports concerning the depth of anesthesia achieved when inhaled anesthetic is administered to a single lung during bilateral ventilation. In the current case, no major changes in the inspiratory or expiratory desflurane concentration of the healthy lung were observed when bilateral ventilation was switched to DLV. It has been reported that when switching from bilateral ventilation to one-lung ventilation, an uneven balance of ventilation-perfusion between the two lungs can reduce the concentration of inhaled anesthetic in arterial blood [2], indicating that there is a risk of the depth of anesthesia being insufficient, even if the inspiratory and expiratory anesthetic concentrations remain stable. Although a postoperative interview with the patient did not indicate that any intraoperative awakening had occurred, it might be preferable to control intravenous anesthesia with a bispectral index monitor instead of an inhalational anesthetic to avoid intraoperative awakening. Further evaluation of the depth of anesthesia achieved in cases involving the uneven administration of inhaled anesthetic to the lungs is necessary in future.

**CONSENT FOR PUBLICATION:** Informed consent was obtained from the patient for the publication of this case report.

**COMPETING INTERESTS:** The authors declare that they have no competing interests.

**AUTHORS’ CONTRIBUTIONS:** HK and SA were involved...
in patient care during the operation and prepared the manuscript. TH carried out the anesthetic management and substantially contributed to drafting the manuscript. KU helped to draft the manuscript. All of the authors have read and approved the final manuscript.

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