

Positive pressure ventilation in a patient with a right upper lobar bronchocutaneous fistula: right upper bronchus occlusion using the cuff of a left-sided double lumen endobronchial tube

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Abstract In patients with a bronchocutaneous fistula, positive pressure ventilation leads to air leakage and potential hypoxemia. A male patient with a right upper bronchocutaneous fistula was scheduled for esophageal reconstruction. His preoperative chest computed tomography image revealed aeration in the right middle and lower lobe, a large bulla in the left upper lobe, and pleural effusion and pneumonia in the left lower lobe. Therefore, left one-lung ventilation was considered to result in hypoxemia. Before anesthesia induction, the bronchocutaneous fistula was covered with gauze and film to prevent air leakage. After anesthesia induction, mask ventilation was performed with a peak positive pressure of 10 cmH₂O. A left-sided double lumen endobronchial tube (DLT) was then inserted into the right main bronchus for occluding only the right superior bronchus, and two-lung ventilation was performed to minimize airway pressure and maintain oxygenation, which did not cause air leakage through the fistula. During anesthesia, no ventilation-related difficulty was faced. The method of inserting a left-sided DLT into the right main bronchus and occluding the right upper bronchus selectively by bronchial cuff is considered to be an option for mechanical ventilation in patients with a right upper bronchial fistula, as demonstrated in the present case.

Keywords Bronchocutaneous fistula · Bronchopleural fistula · Positive pressure ventilation · Double lumen endobronchial tube

Introduction

During positive pressure ventilation for patients with a bronchocutaneous fistula, a portion of inspired gas escapes through the fistula. Therefore, in general anesthesia, management of air leakage from the fistula is essential. If these patients have pneumonia or respiratory dysfunction, respiratory management during general anesthesia is very difficult.

Here, we report on a patient with a bronchocutaneous fistula in the right upper lobe, and a large bulla and pneumonia in the left lung, who underwent reconstruction of the esophagus with the free jejunum flap. During surgery, positive pressure ventilation was established by right upper lobar bronchus occlusion using a left-sided double lumen endobronchial tube (DLT) cuff placed in the main right bronchus.

Case presentation

A 72-year-old man underwent thoracoscopic esophagectomy with anastomosis of the gastric conduit to the cervical esophagus via the posterior mediastinum for multiple esophageal and gastric cancers. Nine months after surgery, he developed an esophageal-pulmonary fistula in the region of the anastomosis between the esophagus and the gastric conduit. Therefore, he underwent extraction and partial resection of the gastric conduit, cervical esophagostomy, enterostomy, partial right upper lobectomy, and pleural

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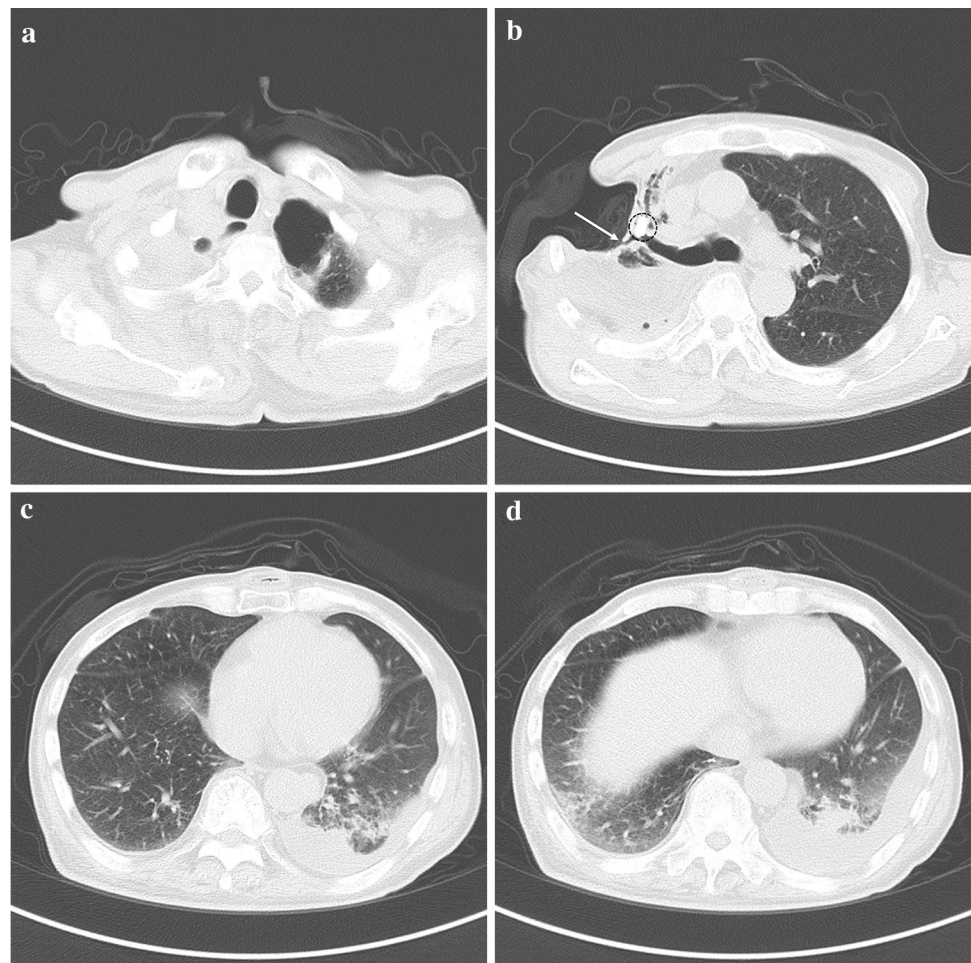
defect repair using the latissimus dorsi skin-muscle flap. During the perioperative period, positive pressure ventilation was performed uneventfully. Since the fistula was located cephalad to the tracheal bifurcation, a cuff of an endotracheal tube could seal the fistula and prevent air leakage. One month later, he developed a bronchopleural fistula that was treated by placement of an endobronchial Watanabe spigot (EWS) at the distal portion of the right upper bronchus with awake bronchoscopy. Two months later, the bronchopleural fistula recurred because of EWS displacement, so he underwent right thoracostomy under general anesthesia using left one-lung ventilation with a left-sided DLT. Four months later, he was scheduled for reconstruction of the esophagus with the free jejunum flap.

The patient was 153 cm tall and weighed 43.3 kg. His preoperative blood examination revealed slight inflammation including a white blood cell count of 14,000/ μL and a serum C-reactive protein level of 1.8 mg/dL. Chest computed tomography (CT) revealed a bronchocutaneous fistula and EWS displacement in the right upper lobe, normal aeration of the right middle and lower lobe, a large bulla in the left upper lobe, and pleural effusion and pneumonia in

the left lower lobe (Fig. 1). Before surgery, we measured the diameters of the right main bronchi (13 mm) and right upper lobar bronchus (9 mm) using the preoperative CT image (Fig. 2). We attempted to prevent air leakage through the fistula in the right upper lobe and expansion of the bulla in the left lung. For two-lung ventilation with right upper lobar bronchus occlusion, we prepared a 35-French left-sided DLT (Mallinckrodt™; Medtronic, Boulder, CO, USA), with a bronchial cuff 17 mm in length and 9 mm in diameter. The tip of the DLT was retroverted, similar to a right-sided DLT.

In the operating room, his arterial oxygen saturation was 95% in room air and body temperature was 37.5 °C. A thoracic epidural catheter was placed at the T8–T9 intervertebral space. Before anesthetic induction, the bronchocutaneous fistula was covered with gauze and film to prevent air leakage. General anesthesia was induced with administration of propofol (70 mg) and fentanyl (50 μg). We performed mask ventilation with a peak positive pressure of 10 cmH_2O , which did not result in air leakage through the fistula. Rocuronium (50 mg) was then administered. The tip of the DLT was inserted into the trachea via direct

Fig. 1 Chest computed tomography (CT) image of the patient immediate before reconstruction of the esophagus with the free jejunum flap. **a** Large bulla in the left lung. **b** Bronchocutaneous fistula (*arrow*) and displacement of the endobronchial Watanabe spigot (*dashed circle*) in the right upper lobe. **c** Aeration of the middle and lower lobe of the right lung. **d** Pleural effusion and pneumonia in the left lung



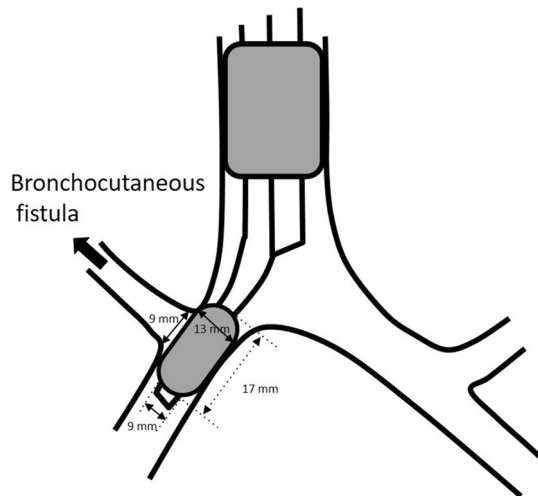


Fig. 2 Preoperative bronchial tree diagram illustrating the insertion of a left-side double lumen endobronchial tube into the right main bronchus and the occluded right upper lobar bronchus

laryngoscopy, and then inserted into the right main bronchus with a fiberoptic bronchoscope. The bronchial cuff was placed at the inlet of the right upper lobar bronchus and was inflated to occlude it. The respiratory sound was auscultated in all lung fields except for the right upper lung field, and air leakage through the bronchocutaneous fistula stopped. When the bronchial cuff was deflated, air leakage occurred. Hence, the inflated bronchial cuff was considered to occlude the right upper bronchus selectively (Fig. 3). Under the inflation of the bronchial cuff, the patient received pressure-controlled ventilation with a fraction of inspired oxygen of 0.45, positive end-expiratory pressure of 5 cmH₂O, peak inspiratory pressure of ≤ 20 cmH₂O, and a respiratory rate of 12/min. In this ventilator setting, approximately 300 mL of tidal volume was obtained without air leakage through the fistula, and the arterial blood gas analysis showed a pH of 7.32, arterial oxygen tension of 170 mmHg, and arterial carbon dioxide tension of 50 mmHg. Anesthesia was maintained with continuous infusion of propofol (3.5–4.2 mg/kg/h) and remifentanyl (0.3–0.5 μ g/kg/min), and an intravenous bolus of fentanyl (total 1.0 mg) and rocuronium (total 280 mg). Epidural analgesia was maintained with a bolus of 2.5 ml 0.75% ropivacaine and subsequent continuous infusion of 0.25% levobupivacaine containing 2.5 μ g/ml fentanyl (4 ml/h). Continuous infusion of phenylephrine (0.5–1.5 mg/h) and an intravenous bolus of 4 mg ephedrine (total 20 mg) were used to prevent hypotension. The patient underwent antesternal esophageal anastomosis with interposition of the free jejunal graft. During anesthesia, no air leakage was detected and no ventilatory difficulty occurred. After recovery from anesthesia, the patient's endobronchial tube was removed in the operating room. The duration times of



Fig. 3 Postoperative chest radiograph of the patient. The left-sided double lumen endobronchial tube is inserted into the right main bronchus

surgery and anesthesia were 629 and 727 min, respectively. During anesthesia, blood loss, urine output, and volume of infusion were 306, 1085, and 4300 mL, respectively. The patient was then transferred to the intensive care unit with 3 L/min of supplemental oxygen administered via a mask, and continuous epidural of 4 mL/h 0.25% levobupivacaine containing 2.5 μ g/mL fentanyl and intravenous 20 μ g/h fentanyl for postoperative analgesia.

Discussion

Here, we report a case of positive pressure ventilation in a patient with a right upper lobar bronchocutaneous fistula via occlusion of the fistula using the cuff of a left-sided double lumen endobronchial tube. The major cause of a bronchopleural fistula is suture insufficiency of the bronchial stump [1–3]. Mechanical ventilation is a major problem during general anesthesia for patients with bronchocutaneous fistulas. There are several reports on the anesthetic management of bronchopleural fistulas [4–9]. In these reports, one-lung ventilation was performed as the first-line technique for respiratory management [4–7], and a DLT was often used [5–7]. In addition, positive airway pressure, high flow jet ventilation to the nondependent lung, and a bronchial blocker for occluding the fistula have been

reported [6–8]. Moreover, a case maintaining spontaneous respiration has also been reported [9].

The patient underwent a couple of surgical procedures with a right upper lobar bronchial fistula. At the time of the right upper thoracostomy, left one-lung ventilation was successfully performed because the patient's left lung was not damaged, and the surgery was performed under left lateral decubitus position, which reduced the ventilation–perfusion mismatch. However, during reconstruction of the esophagus with the free jejunum flap, several problems associated with the lung were encountered—a bronchocutaneous fistula in the right upper lobe, a large bulla in the left upper lobe, and pneumonia and pleural effusion in the left lower lobe. Since a bronchocutaneous fistula can cause massive air leakage, large bulla can rupture and lead to pneumothorax, and pneumonia and pleural effusion can cause inflammation and subsequent deterioration of oxygenation during mechanical ventilation, air leakage should be prevented and airway pressure during mechanical ventilation should be minimized. Closing the fistula with gauze and film might cause ventilatory failure due to the accidental detachment of the dressing materials. In addition, during surgery under supine position, one-lung ventilation can cause hypoxemia because the body position cannot reduce ventilation–perfusion mismatch. Therefore, we selected two-lung ventilation with right upper lobe occlusion. For this purpose, we inserted a left-sided DLT into the right bronchus. This method has several advantages over bronchial blockers and preservation of spontaneous respiration. As the DLT occluded the right upper lobe only, we could therefore ventilate all other lobes, perform one-lung ventilation in the case of pneumothorax, and ventilate the left and right lung separately in the case of further respiratory status deterioration, which requires postoperative mechanical ventilation. Moreover, without using a muscle relaxant, mobilization of the gastrointestinal tract and microscopic vascular anastomosis could become more difficult due to abdominal muscle tension and thoracic motion for spontaneous respiration. In this case, however, we could freely use a muscle relaxant, which facilitated surgical procedures and enabled the suctioning of pulmonary secretions without cough reflex.

However, the placement of a left-sided DLT in the right bronchus encountered the following issues. The left-sided Mallinckrodt™ DLT is made of polyvinyl chloride, which is firmer than silicon products, and is inserted into the left bronchus. Therefore, the fixation of a left-sided

Mallinckrodt™ DLT to the right bronchus tends to be unstable. A flexible DLT such as a silicon-made DLT is considered to be feasible to improve fixation.

In conclusion, one-lung ventilation using a DLT is commonly performed in patients with a bronchocutaneous fistula. However, we performed two-lung ventilation with selective occlusion of the bronchocutaneous fistula at the right upper lobe using a DLT because the patient had difficulty in maintaining oxygenation with one-lung ventilation. In patients with a bronchial fistula in the right upper lobe, such as in the present case, placement of a left-sided DLT into the right main bronchus is considered a useful option.

Compliance with ethical standards

Conflict of interest None.

Informed consent Written informed consent was obtained from the patient for publication of this case report.

References

1. Asamura H, Kondo H, Tsuchiya R. Management of the bronchial stump in pulmonary resections: a review of 533 consecutive recent bronchial closures. *Eur J Cardiothorac Surg*. 2000;17:106–10.
2. Shekar K, Foot C, Fraser J, Ziegenfuss M, Hopkins P, Windsor M. Bronchopleural fistula: an update for intensivists. *J Crit Care*. 2010;25:47–55.
3. Li SJ, Zhou XD, Huang J, Liu J, Tian L, Che GW. A systematic review and meta-analysis—does chronic obstructive pulmonary disease predispose to bronchopleural fistula formation in patients undergoing lung cancer surgery? *J Thorac Dis*. 2016;8:1625–38.
4. Harutaka U, Kenichi S, Takeshi S, Masahito H, Michio Y. Anesthetic management of a patient with pharyngeal cancer complicated with bronchocutaneous fistula. *Masui*. 1985;34:1263–6.
5. Hindman BJ, Bert AA. Malignant esophago-respiratory tract fistulas: anesthetic considerations for exclusion procedures using esophageal bypass. *J Cardiothorac Anesth*. 1987;1:438–47.
6. Wendt M, Hachenberg T, Winde G, Lawin P. Differential ventilation with low-flow CPAP and CPPV in the treatment of unilateral chest trauma. *Intensive Care Med*. 1989;15:209–11.
7. Zdenek O, Dontuald O. Lobar bronchial blockade in bronchopleural fistula. *Can J Anaesth*. 1992;39:176–8.
8. Tsui SL, Lee TW, Chan ASH, Lo JR. High-frequency jet ventilation in the anesthetic management of a patient with tracheoesophageal fistula complicating carcinoma of the esophagus. *Anesth Analg*. 1991;72:835–8.
9. Miho A, Takayuki K, Yoshitsugu Y. Cancer and esophagobronchial fistula: a case report. *Masui*. 2009;58:1175–8.