How-to-do-it
Use of a modified endobronchial tube for mechanical ventilation of patients with bronchopleural fistula

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Abstract
Mechanical ventilation in patients with bronchopleural fistula after lung resection is a major problem, as it causes increase of the air-leak, complicates the healing process and makes residual lung tissue ventilation difficult. We present two cases in which the use of a modified double lumen endobronchial tube improved ventilation and eliminated the fistula air-leak. We used a right-sided double lumen \textit{sher-i-branch\textsuperscript{c}} tube (Sheridan Catheter Corp., USA). This method, by blocking the airflow through the fistula, may facilitate the expansion of the residual lung parenchyma. In both the patients treated with this technique, we obtained a good expansion of the residual parenchyma. Despite the procedure, the first patient died of septic shock; in the second patient, we achieved improvement of the respiratory function, the weaning from the mechanical ventilation, and thereafter, the healing of the fistula. The use of a modified double lumen \textit{sher-i-branch\textsuperscript{c}} tube in mechanically ventilated patients with post-resection bronchopleural fistula allows the anaesthesiologist to suction separately the two lungs and to ventilate adequately the remaining lung tissue, thus obtaining the lung reexpansion and the consequent reduction of the residual pleural space, and facilitating the healing of the fistula.

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1. Introduction
In patients with post-resection bronchopleural fistula, mechanical ventilation is always a problem, either when it is used for the treatment of respiratory failure or during anesthesia for surgery. In fact, bronchopleural fistula causes decrease of the real tidal volume, deflation of the residual pulmonary tissue associated with higher risk of tension pneumothorax and mediastinal shift, as well as failure to maintain satisfactory values of PEEP. Furthermore, the high gas flow through the fistula makes the healing impossible.

We describe two cases in which the use of a modified double lumen endobronchial tube allowed improvement of oxygenation and ventilation.

2. Patients and methods
In two patients mechanically ventilated for post-resection bronchopleural fistula we used a right-sided double lumen \textit{sher-i-branch\textsuperscript{c}} tube (Sheridan Catheter Corp., USA) (Fig. 1). This tube, generally used for selective bronchial ventilation, has two cuffs over the branch for the right lung ventilation, which isolate the orifice for the right upper lobe. We modified the tube, blocking the orifice for the upper lobe ventilation with a silicon plug, with the aim of middle and lower lobes ventilation, excluding the bronchopleural fistula.

2.1. Case 1
A 75-year-old man, who had received right upper lobectomy for NSCLC 5 months before, was admitted to our hospital with the diagnostic suspect of bronchopleural fistula (cough with purulent secretion, fever, and dyspnoea). Chest X-ray showed a right pneumothorax with air-fluid level. A 32-Fr thoracostomy tube was introduced at the fifth intercostal space in the midaxillary line, allowing drainage of purulent secretion and air-leak. Bronchoscopy confirmed the diagnosis of right upper bronchial stump dehiscence. The cardio-respiratory condition deteriorated rapidly; the patient developed cyanosis, increasing dyspnoea, restlessness, blood hypertension (180/100 mmHg), tachyarrhythmias (heart rate: 130/min). Chest X-ray showed a massive collapse of the residual right lung, with persistent air-fluid level and worsening of arterial blood gases (pH 7.13, PaCO\textsubscript{2} 102.3, PaO\textsubscript{2} 52.1 mmHg, HCO\textsubscript{3} \textsuperscript{-} 33.1 mmHg, BE \textsuperscript{-} 0.2). The patient was intubated...
with a left-sided endobronchial tube and ventilated mechanically; the air-leak persisted despite drainage and ventilation of both the lungs. A further chest X-ray revealed a complete collapse of the residual right lung parenchyma, and it was noted that of each 600 ml tidal volume, only 250 ml returned with expiration. Thoracostomy tube connection to $-30$ cmH$_2$O suction failed to achieve negative endopleural pressure and increased moreover the leak of inspired air through the bronchial fistula, causing the complete exclusion of both middle and lower lobes from ventilation. With the aim of improving ventilation through the intermediate bronchus, the fistula was excluded by inserting a right-sided double lumen modified sher-i-bronch™ tube. An immediate, almost complete disappearance of the air-leak and a progressive reexpansion of the residual right lung tissue were obtained, with almost the entire tidal volume returned with expiration. Mechanical ventilation was maintained for other 10 days but, despite a significant improvement of the respiratory condition (pH $7.40$, PaCO$_2$: 51; PaO$_2$: 91.6; HCO$_3$: 33.6; BE 7.4), patient died of overwhelming sepsis.

2.2. Case 2

A 68-year-old man, who had undergone right upper lobectomy for NSCLC 3 months before, returned to us for a suspected bronchopleural fistula. A thoracostomy tube was inserted and maintained for a month, approximately. However, ventilation of residual right lung parenchyma was inadequate. Furthermore, worsening of patient’s condition due to pleural empyema induced us to perform an ‘open window’ thoracostomy. After 3 weeks, during which a standard management of the thoracostomy was continued, the respiratory condition of the patient deteriorated (PaO$_2$: 53.6; PaCO$_2$: 56.6), and necessitated mechanical ventilation, initially by the means of an endobronchial double lumen tube. Despite this measure, the respiratory condition did not improve, as the air-leak persistence could not allow the reexpansion of the residual lung parenchyma. We decided to substitute the traditional tube with a modified double lumen sher-i-bronch™ tube. An immediate decrease of the air-leak and reexpansion of the residual lung tissue was obtained (Fig. 2). After 10 days, the patient was weaned from mechanical ventilation and, successively, he was discharged from hospital.

3. Comment

Among the numerous techniques for assisted ventilation of patients with bronchopleural fistula, independent ventilation (by one or two ventilators) [1], valves modifying both ventilator circuit and drainage system pressures [2,3], and jet ventilation [4] are the most frequently used. It has been demonstrated that persistence of endobronchial positive pressure hinders the fistula healing and that jet ventilation does not have a sufficient efficacy in patients with reduced lung compliance. Another available
technique is selective block of the right upper bronchus by the means of a balloon catheter inserted through a single lumen tube or a double lumen tube, [5,6] but the placement of the system is often difficult and sometimes impossible, in case of patients with short post-resection bronchial stump, unable to retain the inflated balloon. Our technique allowed us to suction separately the two lungs and to ventilate adequately the remaining right lobes, thus obtaining the lung reexpansion and the consequent reduction of the residual pleural space. However, in one case the technique did not prevent the patient’s death, due to septic shock. For this reason, sometimes it could be necessary to consider a more aggressive (possibly surgical) management of the fistula.

References