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Placement of a Customised Y-Shaped Silicone Stent via the Transthoracic Approach for Closing a Large Bronchial Stump Fistula

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ABSTRACT

Bronchial stump fistula occurs at the site of a lobectomy or segmentectomy and is a specific type of bronchopleural fistula. In addition to complications such as empyema and pneumothorax, a large bronchial stump fistula can result in decreased lung ventilation due to significant air leakage, particularly during general anaesthesia with endotracheal intubation, making closure of the large bronchial stump fistula challenging. The present paper reports on a case of a patient with a large right bronchial stump fistula who had difficulty maintaining normal oxygenation when using conventional tracheal intubation for mechanical ventilation. We utilised left-lung single-lung ventilation during the procedure to ensure adequate oxygenation and inserted a customised Y-shaped silicone stent via the transthoracic approach into the right-side fistula to occlude the bronchial stump fistula. A satisfactory outcome was achieved in this case.

1 | Introduction

Bronchopleural fistula (BPF) refers to an abnormal channel between the bronchus and the pleural cavity. A bronchial stump fistula (BSF) is a type of BPF that develops at the bronchial stump following a lobectomy. A large BSF causes severe lung ventilation disorders due to massive air leakage, making it difficult to achieve occlusion through the trachea. The present paper reports on a novel method of using a silicone stent to occlude large BSFs via a transthoracic approach rather than the conventional transtracheal approach.

2 | Case Report

A 57-year-old man underwent right upper lobectomy due to pulmonary adenocarcinoma. One month later, the patient developed fever, sputum production, and dyspnoea, and was diagnosed with right-sided empyema and BSF. Chest drainage was performed but failed to effectively control the empyema. An open window thoracostomy was then conducted to manage the empyema, and sterile gauze was placed in the chest cavity to occlude air leakage. Upon admission to our hospital, the patient could engage in simple conversations using few words and could

walk slowly. Chest CT revealed a 12 mm BSF in the right main bronchus. Bronchoscopy showed a large BSF located on the bronchial stump of the upper right lobe (Figure 1). After 2 weeks of treatment, including pleural dressing changes, nutritional support, and intravenous cefoperazone-sulbactam (pleural effusion culture tested positive for *Pseudomonas aeruginosa*), the patient underwent airway stent implantation for BPF closure.

After general anaesthesia, an endotracheal tube (Jinlin Medical Appliances Company, Hangzhou, China) with an inner diameter of 8.5 mm was introduced into the left main bronchus via a bronchoscope for one-lung ventilation. A Y-shaped silicone stent (Tracheobronxane, Novatech, LA Ciotat, France), measuring 16-13-13 mm, was cut to be 3 cm long in the main trunk, 2 cm long in the left branch, and 1 cm long in the right branch. Sterile gauze inside the thoracic cavity was removed. The stent was placed into the right main bronchus through the fistula via the transthoracic approach. At this point, the silicone stent almost completely occluded the BSF, and the air leakage was temporarily blocked. The endotracheal tube was then retracted approximately 5 cm to ventilate both lungs. A biopsy forceps entered the trachea, clamped the proximal end of the stent, and pulled it close to the carina so that the stent entered the right main bronchus and was released. The stent was subsequently pushed distally by the biopsy forceps while another pulmonologist simultaneously used a vascular clamp to pull the right branch of the stent from the side of the chest until the main trunk of the stent was in the right main bronchus, the left branch of the stent was in the intermediate bronchus, and the right branch of the stent protruded into the thoracic cavity through the fistula. Finally, the right branch of the stent was occluded by the vascular clamp to prevent air leakage. After confirming the successful placement of the stent by bronchoscopy, the right branch of the stent was sutured from the side of the chest (Figure 2).

After the operation, the patient's air leakage improved, and the patient gradually resumed normal exercise. During the

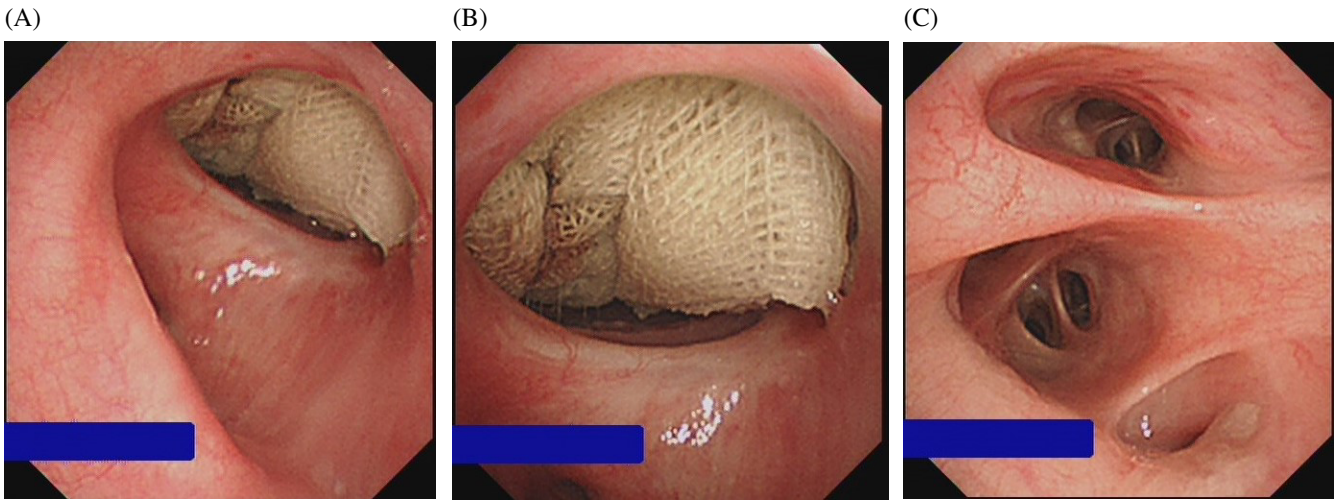

FIGURE 1 | (A): The right main bronchus was shown with a large BSF located on the right upper stump. (B): The sterile gauze inside the right thoracic cavity was observed through the large BSF. (C): A normal intermediate bronchus was reviewed.

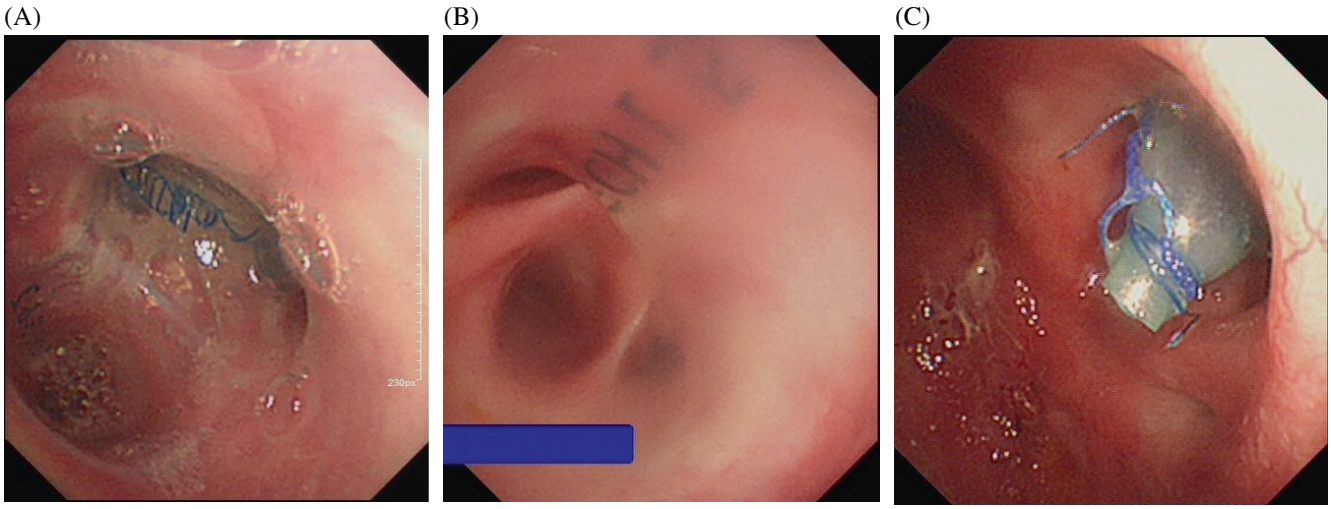

FIGURE 2 | (A): A Y-shaped silicone stent was successfully deployed with its main trunk in the right main bronchus, its left branch in the intermediate bronchus, and its right branch protruding into the thoracic cavity through the fistula. (B): The left branch of the silicone stent did not cover the middle lobe bronchus or the lower lobe bronchus. (C): The right branch of the stent protruded into the thoracic cavity through the fistula and was sutured.

6-month follow-up, the patient did not redevelop a BPF or empyema.

3 | Discussion

When BSF develops, microorganisms from the lungs and airways, along with airway secretions that can serve as culture media for these microorganisms, enter the thoracic cavity through the BSF, resulting in empyema. Additionally, a large volume of air from the lungs enters the thoracic cavity via the BSF, leading to pneumothorax. The larger the fistula, the more obvious the air leaks become. There is no consensus on the definition of large BSFs up to now. Some scholars consider fistulas larger than 8 mm to be large BSFs [1], while others define fistulas between 6 and 8 mm as large BSFs, and those larger than 8 mm as very large BSFs [2].

Closure of large BSFs had previously been performed using surgical methods [2], which involved the transthoracic approach. With advancements in bronchoscopy technology and occluding materials, more patients underwent bronchoscopic treatment for large BSFs [3], utilising the trans-tracheal approach. However, due to significant pulmonary air leakage, ventilation during the procedure becomes a major challenge. When air leakage is too extensive to support effective oxygenation, double-lumen intubation or contralateral one-lung ventilation becomes an ideal choice. Since the inner diameter of the tracheal tube used for double-lumen or one-lung ventilation is generally smaller than the outer diameter of the bronchoscope, performing bronchoscopic closure of BSFs becomes impractical.

To solve this clinical problem, extracorporeal membrane oxygenation [4] or epidural anaesthesia [5] was considered for the operation. Obviously, these two methods cannot be routinely used. The present strategy is another choice: using conventional trans-tracheal materials but via a transthoracic approach. Firstly, oxygenation was supported by one-lung ventilation. Secondly, a customised Y-shaped silicone stent was deployed into the bronchus through the fistula via the transthoracic approach to occlude the BSF.

To the best of our knowledge, this is the first report of transthoracic stent placement for a BSF. This method does not occupy the ventilation airway, significantly enhancing the safety of the operation and making it suitable for promotion due to its simplicity. Additionally, this method avoids more serious injuries associated with thoracic surgery, such as those involving the omentum, pericardium, or muscle flap transplantation [2]. Although the present procedure can ensure the safety of intraoperative ventilation, it is important to emphasise that it requires an unobstructed transthoracic approach for stent placement; that is, this procedure is particularly suitable for patients who have undergone open window thoracostomy.

Author Contributions

Junqi Zhu: writing the manuscript, investigation, methodology. **Chan Xu:** collecting the relevant clinical data, investigation. **Honglei Tao:** ensuring the accuracy or integrity of the operation, methodology. **Shunxin Xin:** revising the manuscript, methodology. **Weihua Xu:** designing the operation, final approval of the version to be published, methodology.

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Ethics Statement

The authors declare that appropriate written informed consent was obtained for the publication of this manuscript and accompanying images.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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