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**Abstract**

**Background:** Bronchopleural fistula (BPF) is a rare but serious complication of pulmonary resection. Its clinical impact depends on: timing of onset, size, underlying cause and patient's condition. Management of BPF is complex and ranges from conservative and endoscopic techniques to extensive surgical procedures. A multidisciplinary approach is essential for optimal treatment planning.

**Case presentation:** We report the case of a 76-year-old female with stage IIB pulmonary adenocarcinoma who underwent right upper lobectomy. The postoperative course was complicated by the development of a refractory BPF which, following multidisciplinary discussion, was initially managed with an open window thoracostomy (OWT), an endobronchial stent and a dermal patch, providing internal and external coverage of the fistulous tract, respectively. Subsequently, due to recurrence of the complication, the patient underwent surgical intervention in order to definitively close the fistula using two muscle flaps (pectoralis major and serratus anterior).

**Conclusions:** this case underscores the importance of a multidisciplinary approach in managing post-lobectomy BPFs. The integration of endobronchial stenting with dual muscle flap reconstruction offered durable closure and clinical improvement. Combining minimally invasive strategies and surgical techniques, with the aid of different medical specialty - each one offering a unique experience in their field - can provide tailored solutions for complex BPFs.

# Multidisciplinary Management of a Post-Lobectomy Bronchopleural Fistula Using Endobronchial Stent and Dual Muscle Flaps (Pectoralis Major and Serratus Anterior): A Case Report

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**Abstract**

Bronchopleural fistula (BPF) is a rare but potentially fatal complication; its incidence is estimated to be between 0.5 and 1.4% [1, 2] after pulmonary lobectomy and 14% after pneumonectomy [1]. The etiology varies from oncological pathologies, particularly as a complication of pulmonary resective surgery, to infectious, post-traumatic conditions and following chronic pleuro-pulmonary pathologies.

The clinical presentation is essentially conditioned by four aspects: size of the fistula, timing of onset (early, intermediate and late), context in which it developed (infectious, oncological, post-traumatic) and patient fitness. The most common symp-

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toms are: persistent cough possibly associated with purulent sputum, dyspnea and more rarely hemoptysis. Furthermore, symptoms may be associated with signs such as: fever, leukocytosis, persistent air losses when a chest drainage has been positioned and pneumothorax; finally "vomica" (sudden expectoration of purulent material) can happen.

Diagnosis is often suspected when one or more of the previously mentioned sings or symptoms occur. In particular, a BPF is clinically suspected in case of prolonged air leaks from the chest drain with no parenchymal lesions, or by a reduction in the air-fluid level in patients who underwent pneumonectomy. Imaging is crucial for confirmation: in most cases, a contrast-enhanced chest CT scan in sufficient to localize and morphologically define the fistula, assess its characteristics – particularly its size – and identify additional associate causes (such as a bronchial stump dehiscence, infection or necrosis). Flexible bronchoscopy is another valuable tool, not only to confirm the presence of a BPF but also to perform therapeutic maneuvers during the endoscopic session, such as the application glue, endobronchial valves or stents. Finally, fistulography can be performed, although this exam has largely been replaced by contrast-enhanced CT. It remains useful to rule out the presence of multiple fistulous communications.

The management of BPF remains a major challenge, with extremely high mortality rates in cases where the condition is not promptly recognized. The mortality of post-lobectomy fistulas is lower (14% [3]) compared to those following pneumonectomy (30% [4]). This difference is mainly due to the smaller residual cavity, the lower risk of infection with subsequent empyema, and the reduced risk of aspiration or "vomica".

Initial management primarily involves patient stabilization, which includes the placement of a chest tube and a broad-spectrum antibiotic therapy in the early phase. The ultimate goal is to close the fistula, taking into account four key aspects: timing of onset, size, specific characteristics, and the patient's underlying condition. Treatment strategies range from conservative and endoscopic approaches (such as the placement of one-way valves, sealants, stents or sponges/plugs) – typically reserved for small fistulas – to surgical intervention. Surgery is usually indicated for very precocious fistulas (within 72 hours), aiming at revision of the bronchial stump with re-suturing or coverage using reinforcing materials (muscle, pericardium, mediastinal fat, omentum or diaphragm). In some cases, an open window thoracostomy (OWT) may be performed to allow drainage of the pleural cavity, followed by delayed closure once the infection has been controlled. Additional surgical options include muscle flaps and omentoplasty. In most cases, treatment is discussed and agreed upon within a multidisciplinary team setting, since multiple therapeutic options are often considered and may even be combined.

## Case Presentation

In this study, we present the case of a 76 year-old female patient with non-small cell lung cancer (NSCLC, pulmonary adenocarcinoma, pT3N0 – stage IIB) who underwent right upper lobectomy at another institution. The patient was in good general condition and reported a history of smoking, habit that she had quit 10 years earlier. Her past medical history was clear for prior oncological pathologies; she reported to suffer from arterial hypertension, which was controlled with antihypertensive drugs.

The patient underwent right upper lobectomy with hilar and mediastinal lymphadenectomy via lateral thoracotomy on March 10, 2025. The postoperative course was initially uncomplicated and she was discharged home. A month later the patient was admitted to the Emergency Department of another hospital due to dyspnea and swelling of the chest wall synchronous with respiratory movements, a condition that had been present for two weeks but has been disregarded by the patient herself. She was stabilized with a chest tube, that revealed continuous air leak suggestive for bronchopleural fistula, and oxygen therapy. A flexible bronchoscopy confirmed the presence of a fistula at the level of the resected bronchial stump. The patient was subsequently referred to our institution for further management. At the time of admission, she appeared in poor general condition and was unable to speak.

At the beginning of May, an open window thoracostomy (OWT) was created at the site of the previous surgical scar with partial resection of the right 3$^{rd}$, 4$^{th}$ and 5$^{th}$ ribs. Using a CT-based reconstruction and real-time measurements via endoscopy, an endobronchial prosthesis was placed to cover the fistulized bronchial stump at the junction between the main and the intermediate bronchus. To externally cover the fistula, a dermal patch (Integra®, Dermal Regeneration Template) was applied in collaboration with the plastic surgery team, following curettage of the fistula margins and closure of the bronchial edges with three interrupted 3/0 Vycril™ sutures.

Postoperatively, thoracostomy dressings and antibiotic therapy were continued, along with a vacuum assisted closure (VAC) therapy. The VAC treatment was complicated by acute pulmonary edema on the first day, leading to its immediate suspension. Treatment was resumed the following day, with good tolerance. VAC therapy was continued throughout the hospitalization. The patient was discharged in July, after almost two months of hospital staying, with the endobronchial stent in place, cessation of the VAC therapy and complete resolution of air leaks.

Three months after stent placement, and during a period of overall clinical stability, the patient reported increased coughing – without purulent sputum – along with a wheezing sensation during breathing through the OWT. The patient was therefore admitted on August 4$^{th}$ for further evaluation. A flexible bronchoscopy documented a minimal air leak laterally to the stent, which remained well positioned. However, the previously applied dermal patch was no longer visible, likely due to an accidental removal during VAC dressing changes.

With negative microbiological coltures, consultation with the plastic surgery team was undertaken, and closure of the BPF and OWT was performed using a pectoralis major muscle flap and an anterior serratus muscle flap. The patient underwent surgical toilette of the fistulous tract with freshening of the wound margins. A split pectoralis major muscle flap (Figure 1) was mobilized, packed into the defect, and secured to the fistula margins with anti-decubital sutures placed circumferentially (3/0 Vycril™) (Figure 2 and 3). For additional filling of the cavity – now largely occupied by the pectoralis major muscle flap – human fibrin glue (Tisseel, Baxter™) was also applied (Figure 4).

To reinforce the previously placed muscle flap, an anterior serratus muscle flap was also mobilized. Two drains were positioned – one in the submuscular plane and one in the subcutaneous plane (Figure 5) – both connected to suction and removed on postoperative days IV and V, respectively. Layered wound closure was then performed. The patient was discharged

home on postoperative day V and she was instructed to maintain a Desault brace in place for three weeks.

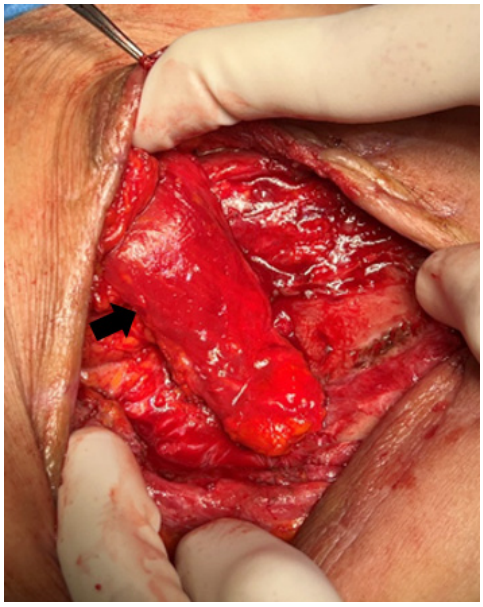

**Figure 1:** Pectoralis major muscle flap (black arrow).

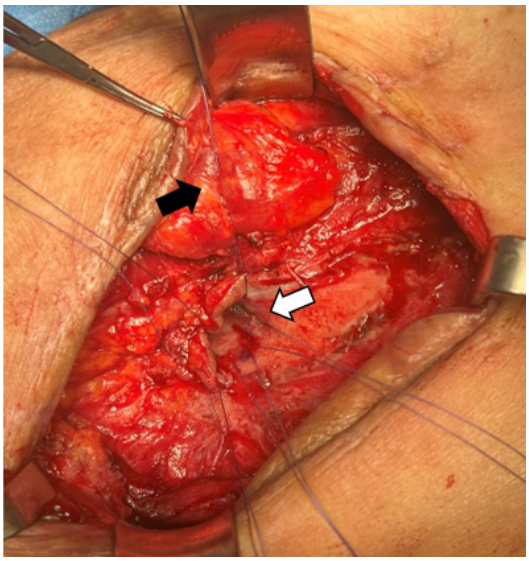

**Figure 2:** Pectoralis major muscle flap (black arrow) and the fistula (white arrow).

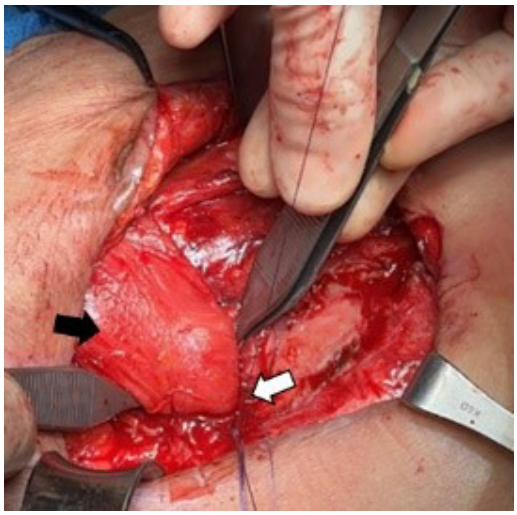

**Figure 3:** Pectoralis major muscle flap (black arrow) packed into the fistolous tract (white arrow).

**Figure 4:** Use of human fibrin glue to further seal the space.

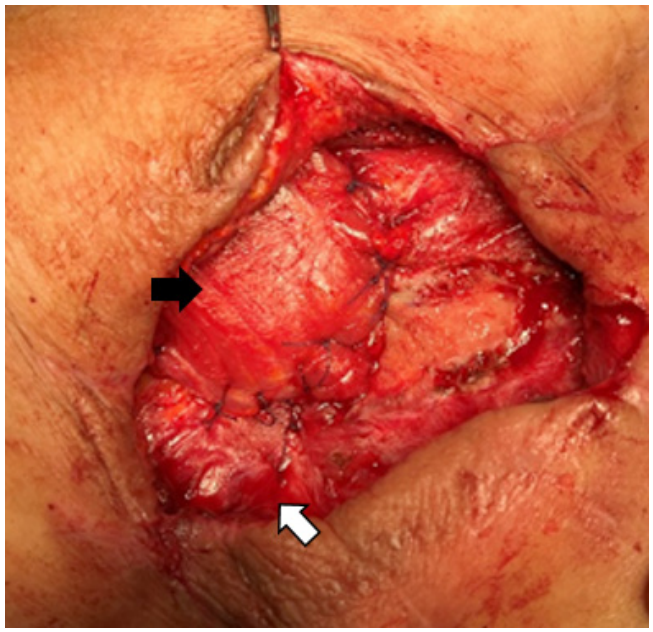

**Figure 5:** Pectoralis major muscle flap (black arrow) and anterior serratus muscle flap (white arrow).

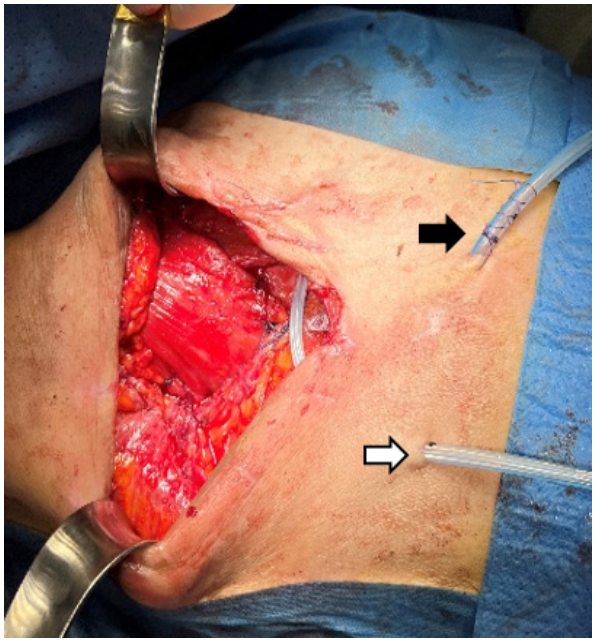

**Figure 6:** Submuscular drain (black arrow) and subcutaneous drain (white arrow).

## Discussion

A bronchopleural fistula (BPF) is defined as an abnormal communication between the bronchial tree and the pleural space, and represents one the most feared and challenging complications to manage. In most cases, it occurs as a complication of pulmonary resection surgery, particularly following pneumonectomy. Its incidence is variable, depending on the type of procedure performed and, in case of pneumonectomy, also on the side involved. Although BPFs occurring after lobectomy are less common as previously mentioned, they remain a clinically relevant event, as they are associated with increased morbidity, prolonged hospital stay and significant mortality.

The management of BPFs is complex and largely depends on the timing of onset. According to the Varoli classification [5], BPFs can be categorized in early (occurring between 1 and 7 days), intermediate (between 8 and 30 days) and late (> 30 days). Post-surgical fistulas usually manifest as early or intermediate. Given the significant clinical risks associated with these complications, early recognition and treatment are crucial. In this regard, multidisciplinary approach and individualized therapeutic strategies are essential for appropriate management and improved prognosis. Key figures in the patient's care include the thoracic surgeon, pulmonologist, infectious disease specialist, oncologist, anesthesiologists and radiologist; in addition, the plastic surgeon plays an important role in chest wall reconstruction and in providing muscle flaps for large fistulas [6].

For small BPFs (< 3 mm) a watch-and-wait approach may be considered; otherwise, closure of the fistula may be attempted using minimally invasive techniques such as endobronchial stents, one-way valves and fibri-based sealants [7]. In intermediate/late and large fistulas, as in the present case, re-suturing of the bronchial stump is not feasible. In these situations, once any infection has been eradicated, closure of the fistula can be achieved using muscle-flaps, combined with endobronchial stent to provide double coverage of the fistulous tract, as in this case.

Muscle flaps are widely used to reduce dead space and promote tissue healing, primarily due to their robust vascularization, which helps decrease the risk of local infection [8]. The most commonly used muscles include the latissimus dorsi, intercostals, pectoralis major and minor, and the serratus anterior. The patient's muscle trophism and the previous surgical approach may influence the choice of muscle to be used. Also, it is essential that the vascular pedicle is preserved in order to ensure the viability of the transferred tissue [9].

In our case, the pectoralis major muscle was chosen for flap creation because the patient presented with poor muscle mass, preventing the use of intercostal muscles. Similarly, the latissimus dorsi muscle was not considered as it was poorly represented and had been partially divided during previous surgical procedures. The pectoralis major was therefore selected owing to its size and its dual blood supply from the thoracoacromial trunk and the perforating branches of the internal mammary artery [10]. It should be noted that the use of muscle flaps can result in functional consequences (e.g. winged scapula, reduced upper limb mobility) and aesthetic issues. Nonetheless, these risks must be balanced against the high mortality associated with BPF, making it essential to discuss them carefully with the patient.

## Conclusions

With this case report we aim to highlight the role of multidisciplinary discussion in the proper management of BPFs, since each medical specialty involved contributes with unique expertise. In particular, the combination of minimally invasive techniques, such as endobronchial stent placement, with more complex strategies, including the use of double muscle flaps, proved to be an effective approach in the treatment of a refractory bronchopleural fistula.

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### Conflicts of Interest

The authors have no conflicts of interest to declare.

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