

## MANAGEMENT OF POST-TUBERCULOUS BRONCHOPLEURAL FISTULAS: SURGICAL CHALLENGES AND MODERN APPROACHES

Toxirov Javoxirbek Alisher O'g'li

Central Asian medical university

**Abstract:** *Bronchopleural fistula (BPF) is a rare but severe complication frequently encountered in post-tuberculosis lung surgery, particularly following lobectomy or pneumonectomy. It is associated with prolonged morbidity, high mortality, and complex management requirements. This article explores the pathogenesis, risk factors, diagnostic strategies, and treatment modalities of BPF in post-tuberculous patients. Emphasis is placed on surgical techniques, including thoracoplasty, muscle flap closure, and minimally invasive approaches. The review also outlines emerging therapies and recommends a multidisciplinary strategy to improve patient outcomes.*

**Keywords:** *bronchopleural fistula, tuberculosis, thoracic surgery, post-operative complication, lobectomy, thoracoplasty, phthisiology, muscle flap*

Bronchopleural fistula (BPF) remains one of the most feared complications in thoracic surgery, particularly in patients who have undergone surgical intervention for pulmonary tuberculosis. A BPF is defined as an abnormal communication between the bronchial tree and the pleural space, resulting in persistent air leaks, recurrent infections, and the potential for life-threatening empyema or sepsis. In the context of tuberculosis, the risk of BPF is compounded by chronic inflammation, cavitory lesions, and impaired tissue healing, making prevention and treatment especially challenging.

Post-tuberculous patients undergoing lobectomy or pneumonectomy are at elevated risk due to the nature of the diseased lung tissue and the high bacterial burden. The surgical closure of bronchial stumps in fibrotic or inflamed tissues can be unreliable, increasing the likelihood of dehiscence and fistula formation. Therefore, understanding the predisposing factors, early recognition of symptoms, and timely implementation of targeted treatment strategies are vital in reducing mortality and improving quality of life in these patients.

Bronchopleural fistula (BPF) is one of the most dreaded postoperative complications in thoracic surgery, particularly in patients who undergo lung resections due to advanced pulmonary tuberculosis. This condition is not only technically difficult to manage but also associated with high morbidity and mortality. In tuberculosis-related cases, BPF

often arises after lobectomy or pneumonectomy when the bronchial stump fails to heal appropriately and an abnormal connection is formed between the bronchial tree and the pleural cavity. The presence of caseous necrosis, severe tissue inflammation, high mycobacterial load, and delayed wound healing in TB patients makes the bronchial stump particularly vulnerable to dehiscence. The resulting fistula leads to continuous air leakage into the pleural space, recurrent infections, empyema, and, in severe cases, respiratory failure and sepsis.

The pathogenesis of BPF in post-tuberculous patients is multifactorial. Persistent infection, inadequate control of the mycobacterium, poor nutritional status, and excessive tension on the bronchial closure site contribute to the development of the fistula. In many patients, tuberculosis leads to fibrosis, vascular compromise, and tissue fragility, which significantly impair the normal healing process. Moreover, the presence of residual cavitory lesions or bronchiectasis can increase the chances of persistent communication between airways and the pleural space. In pneumonectomy cases, the risk is further elevated when the bronchial stump is not properly reinforced, particularly on the right side, where anatomical factors favor fistula formation.

Diagnosis of BPF requires high clinical suspicion, especially in the early postoperative period when patients present with signs of air leak, subcutaneous emphysema, fever, purulent sputum, or respiratory distress. Chest radiography and computed tomography (CT) are essential imaging modalities for detecting pleural air collections, fluid levels, and bronchial stump dehiscence. Bronchoscopy remains the gold standard for confirming the presence and location of the fistula, allowing for direct visualization of the bronchial opening and guiding further management.

Once diagnosed, the management of BPF in post-tuberculous patients must be tailored based on the size of the fistula, the timing of its onset, the extent of infection, and the overall health of the patient. In early-stage, small-diameter fistulas, conservative therapy including chest drainage, targeted antibiotic or anti-tuberculous therapy, nutritional support, and bronchoscopic closure with fibrin glue or sealants may be attempted. However, conservative measures are often insufficient in tuberculosis patients due to the extensive destruction of lung parenchyma and persistent infection.

In most cases, especially those with large or persistent fistulas, surgical intervention is required. Surgical management aims to close the bronchial opening, evacuate infected pleural collections, and re-expand the remaining lung tissue where possible. Several techniques are employed depending on the anatomical site, the severity of infection, and the surgeon's experience. Reinforcement of the bronchial stump with vascularized tissue

flaps such as intercostal muscle, latissimus dorsi, or omentum is a widely accepted approach. These flaps not only cover the stump but also improve vascular supply and promote healing.

In cases with chronic empyema and large residual pleural spaces, open window thoracostomy (Eloesser flap) or Clagett procedure may be considered. These staged procedures involve creating an open drainage route for the infected pleural cavity followed by eventual obliteration with muscle or other tissue flaps. Although invasive and requiring prolonged hospitalization, such methods are sometimes the only viable option in critically ill, malnourished, or multiply operated patients.

Thoracoplasty, involving the resection of multiple ribs to collapse the chest wall and eliminate the pleural space, was once the standard for treating chronic TB-related BPF and empyema. While now rarely used due to its disfiguring nature, thoracoplasty still retains a role in select cases where the lung cannot re-expand or where other methods have failed. When performed judiciously and combined with muscle transposition, thoracoplasty can result in complete closure of the fistula and resolution of the infection.

In recent years, minimally invasive approaches have been introduced for managing BPF. Video-assisted thoracoscopic surgery (VATS) allows for debridement, decortication, and application of sealants or muscle flaps with reduced trauma. However, its use remains limited in TB patients due to dense adhesions and distorted anatomy, especially in the post-pneumonectomy space. Nonetheless, in carefully selected patients, VATS offers a valuable tool for both diagnostic and therapeutic intervention.

Endoscopic interventions have also gained attention, especially for high-risk patients who are not surgical candidates. Techniques such as endobronchial stenting, one-way endobronchial valves, application of biological glues, and autologous blood patches have been used with varying degrees of success. While these methods do not always result in permanent closure, they can significantly reduce air leakage and improve the patient's respiratory status, allowing time for further interventions or natural healing.

Another emerging modality in the management of post-tuberculous BPF is the use of stem cell therapy and growth factors to enhance tissue regeneration and healing at the fistula site. While still largely experimental, early results show promise, especially when combined with conventional surgical techniques. These novel therapies aim to address the underlying problem of poor tissue healing in TB patients and may provide future directions for treatment.

Multidisciplinary care is essential in managing BPF. Collaboration between thoracic surgeons, pulmonologists, infectious disease specialists, and nutritionists is critical in

optimizing patient outcomes. Adequate preoperative preparation, including effective anti-tuberculosis therapy, correction of malnutrition, and stabilization of sepsis, is as important as the surgical technique itself. Postoperative care must include regular bronchoscopic follow-up, imaging, respiratory physiotherapy, and continued pharmacologic therapy to ensure successful closure and avoid recurrence.

Despite advances in surgical techniques and perioperative care, BPF remains a significant challenge in post-tuberculosis patients. Mortality rates range from 15% to 50%, depending on the severity of infection and timing of diagnosis. Recurrence is not uncommon, particularly in patients with uncontrolled infection, poor compliance with anti-TB regimens, or multiple comorbidities. Therefore, prevention remains the best strategy. Intraoperative measures such as bronchial stump coverage, avoiding excessive tension, and ensuring sterile operative fields are essential in reducing the incidence of BPF.

Bronchopleural fistula in the context of post-tuberculous thoracic surgery is a complex and serious complication that demands timely recognition and comprehensive management. While surgical closure remains the cornerstone of treatment, the integration of endoscopic methods, novel biologics, and multidisciplinary care significantly improves the prognosis. As research continues to evolve and healthcare systems strengthen their TB programs, the management of BPF will increasingly shift from reactive to preventive strategies aimed at minimizing risk in high-risk surgical candidates.

Bronchopleural fistula represents a life-threatening complication in the postoperative course of tuberculosis-related thoracic surgery, particularly following lobectomy and pneumonectomy. The management of BPF requires an individualized, multidisciplinary approach that combines timely diagnosis, appropriate surgical intervention, and optimized anti-tuberculous therapy. While traditional techniques such as thoracoplasty and muscle flap reinforcement remain effective, minimally invasive methods and endoscopic innovations are expanding the therapeutic arsenal, particularly for high-risk or debilitated patients.

Prevention through meticulous intraoperative technique and comprehensive postoperative care is paramount, especially in TB-endemic regions where comorbidities and resource limitations complicate outcomes. With ongoing research into regenerative medicine and biologic therapies, the future of BPF management lies in combining traditional surgical wisdom with modern, tissue-preserving approaches. Ultimately, improving survival and quality of life for post-tuberculous patients with BPF requires not only surgical precision but also systemic, coordinated TB control and care.

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