Management of Postpneumonectomy Bronchopleural Fistula

From Thoracoplasty to Transsternal Closure

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KEYWORDS

• Pneumonectomy • Bronchopleural fistula • Postpneumonectomy empyema
• Open window thoracotomy • Clagett procedure • Thoracoplasty

KEY POINTS

- Postpneumonectomy empyema with bronchopleural fistula is a severe infection with a high mortality rate.
- Patients undergoing pneumonectomy who are at high risk of developing bronchopleural fistula should have the bronchial stump reinforced with viable tissue.
- Immediate drainage of the infected postpneumonectomy pleural space is essential. Management of bronchopleural fistula depends on size, chronicity, clinical status of patient and optimal access to bronchial stump (transpleural vs transpericardial).
- Achieve sterilization of the pleural cavity through closure of bronchopleural fistula, debridement and serial dressing changes.
- After control of pleural infection, the chest cavity should be obliterated by antimicrobial solution, transposition of muscle flaps, thoracoplasty, or a combination of these options.

INTRODUCTION

Since Evarts A. Graham performed the first reported single stage removal of an entire lung for the treatment of lung cancer on April 5, 1933,[1] pneumonectomy represents one of the most radical procedures performed by surgeons. Given the high rates of morbidity and mortality, pneumonectomy is considered by some to be a "disease" in and of itself. Despite improvements in preoperative patient optimization, surgical technique, and multidisciplinary perioperative care, pneumonectomy continues to be associated with a morbidity rate of greater than 50% and modern mortality rates of 5% to 7%.[2,3] The development of postpneumonectomy empyema (PPE) and bronchopleural fistula (BPF) are feared and challenging complications. In recent series, PPE occurs at a rate between 2% and 16%, whereas the incidence BPF after pneumonectomy is 1.5% to 28%.[3–6] In the setting of PPE, BPFs are present in approximately 60% to 80% of patients and carries a high mortality rate ranging from 21% to 71%.[7–11]

This review focuses on the history and evolution of therapy for the treatment of PPE associated with BPF. The overall goals in management of PPE with BPF are (1) immediate drainage of the pleural space, (2) sterilization of the affected pleural cavity with elimination of infectious sources including BPF, and (3) obliteration of residual pleural space (**Table 1**). The use of various approaches and

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Table 1
Overview of management of PPE with BPF

Drainage of Pleural Space	Control of Infection	Pleural Cavity Obliteration
Tube thoracostomy	Closure of BPF • Endoscopic • Transpleural • Transpericardial	Fill cavity • Antibiotic solution • Muscle transposition
VATS	Irrigation via tube thoracostomy	Thoracoplasty • Full • Extended • Tailored
Thoracotomy • Temporary vs definitive closure	Serial dressing change • Treated gauze • Vacuum dressing	
Open window thoracostomy	Repeated operative debridement	

Abbreviations: BPF, bronchopleural fistula; PPE, postpneumonectomy empyema; VATS, video-assisted thoracoscopic surgery.

techniques is guided by factors including chronicity of the infection, size of the BPF, and patient suitability for the proposed intervention.

RISK FACTORS AND PREVENTION

Prevention of PPE and BPF is paramount and preferable to treatment. It is important to identify patients at high risk for developing these complications and plan the conduct of the pneumonectomy accordingly. Right-sided pneumonectomy, surgery for benign disease, a low forced expiratory volume in 1 second, low carbon monoxide diffusing capacity, and low albumin levels have been identified by multiple groups as risk factors for development of BPF.[3,4,12] Other factors commonly considered as predisposing to BPF are neoadjuvant therapy, diabetes, use of chronic steroid/immunosuppression, and age, although there are some conflicting reports in the literature.[13,14]

Technical factors during the pneumonectomy are important considerations as well. Avoiding devascularization of the bronchial stump, preventing tension on bronchial closure. and ensuring a short bronchial stump are necessary principles to mitigate the risk of BPF occurrence. Oncologically clear surgical margins are essential because the presence of residual or recurrent cancer in the bronchus is another major factor for poor healing and development of BPF. The method of bronchial closure is another factor of interest. Surgeon and institutional experience varies in use of staplers versus manual suturing, but neither technique has been proven to be definitively superior.[3,15]

Prophylactic coverage of the bronchial stump with healthy viable tissue has been endorsed by several groups. There are a multitude of tissue options that have been reported including pericardium, pericardial fat pad, intercostal muscle, pleura, diaphragm, and azygous vein for right-sided pneumonectomy.[16,17] Several groups have shown that coverage of the bronchial stump is associated with lower rates of BPF after pneumonectomy.[4,18,19] A recent metaanalysis of bronchial coverage for prevention of BPF after pneumonectomy was inconclusive owing to significant selection bias given that patients at high risk for developing BPF almost uniformly underwent bronchial stump coverage.[20] Most experts would agree that the principle of prophylactic reinforcement of bronchial stumps in patients at high risk of developing a BPF is sound and advisable. In addition, the harvest of these tissues carries relatively low risk and adds minimal additional time to the operation.

Postoperative mechanical ventilation is also linked to the development of BPF after pneumonectomy. Barotrauma at the bronchial closure can lead to breakdown especially in the setting of other risk factors listed. In 1 study, the rate of BPF after pneumonectomy increased from 3.1% to 19.3% in the setting of mechanical ventilation.[8] Similarly, a recent best evidence article evaluated 8 studies from 1996 to 2013 and concluded that there is a significant relationship between postoperative mechanical ventilation and BPF.[21]

MANAGEMENT

Summarized in **Fig. 1** are the key components of therapy for PPE with BPF. Initial treatment begins with broad spectrum parenteral antibiotics and immediate drainage of the chest. If BPF is