# Emergency drain for post pneumonectomy bronchopleural fistula: a drain placement technique based on the siphon principle

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**Abstract:** Post pneumonectomy bronchopleural fistula (BPF) is a life-threatening complication requiring pleural cavity drainage to avoid acute mediastinal shift and contralateral aspiration pneumonia. Chest drain insertion in this situation may be technically difficult because of drastic anatomical changes such as mediastinal dislocation, diaphragm elevation and, sometimes, massive subcutaneous emphysema. In addition, the most important part of the pleural cavity to be drained is the costophrenic recess that is scarcely drained by a standard chest tube with its tip aiming high and upwards. We propose a safe, simple and effective technique based on the siphon principle to drain the lowest part of the pleural cavity.

**Keywords:** Pneumonectomy; fistula; chest drain; bronchopleural fistula (BPF); empyema; post pneumonectomy empyema

Submitted Jul 28, 2017. Accepted for publication Nov 22, 2017. doi: 10.21037/jtd.2017.11.145 **View this article at:** http://dx.doi.org/10.21037/jtd.2017.11.145

## Introduction

Bronchopleural fistula (BPF) after pneumonectomy is a lifethreatening complication occurring in 2% to 16% of patients (1,2). Diagnosis of BPF should be prompt and is usually obtained with fiberoptic bronchoscopy and CT scan. After diagnosis, the first step is to drain the pleural cavity from the infected effusion (empyema), to prevent hypertensive mediastinal shift and aspiration pneumonia. It may be difficult to safely and correctly perform this manoeuvre because of: (I) the drastic change in anatomy following pneumonectomy, with diaphragm raising and mediastinal shift; (II) the need to drain the lowest part of the cavity effectively by the inserted drainage tube, whose tip should ideally be positioned in the deepest part of the chest (3,4).

Several chest tube placement techniques are available to the surgeons who prefer one or another depending on experience, skill and availability of radiologic devices (ultrasounds-CT guided etc.). We herewith describe our technique of chest tube thoracostomy in case of a BPF, based upon the siphon principle.

#### **Operative techniques**

The aim of this technique is to drain the lowest part of the pleural cavity effectively avoiding mediastinal, diaphragmatic or intra-abdominal organ injuries (*Figures 1-3*).

After an exploratory puncture with local anaesthetic, a skin incision in the  $2^{nd}$  or  $3^{rd}$  intercostal space in the hemiclavear line is made; then, by means of curved Klemmer forceps, the drain is inserted and tunnelled through the  $3^{rd}$  or  $4^{th}$  intercostal space (*Figure 1A*,*B*; *Figure 3B*,*C*). This allows the drain to be safely directed to

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Figure 1 Chest CT scan. (A) Drain tube entering the skin; (B) drain tube entering the chest wall; (C) drain passing distal to mediastinal structures; (D) the tip of the chest tube is positioned in the lowest part of the chest.



**Figure 2** Chest X-ray. (A) The typical drainage course on postero-anterior chest X-ray; note another small apical catheter for irrigation; (B) latero-lateral chest X-ray view of the chest tube course.



Figure 3 3D-multiplanar CT scan. (A) Computed tomography coronal section showing post pneumonectomy left hemidiaphragm and spleen raised; (B) the tunnelled technique on a sagittal computed tomography section; note massive subcutaneous emphysema due to bronchial dehiscence; (C) 3D computed tomography reconstruction of the chest tube course.

the lowest part of the cavity, passing distal to mediastinal and diaphragmatic structures (*Figure 1C,D*). The drain is thus fixed to the skin by a standard purse string suture and the wound medicated with a cylindrical pack of gauzes under the tube, on the skin, to avoid the chest tube kinking. A chest X-ray performed after the procedure allows a proper identification of the tips' end and its potential repositioning if not adequately lodged in the costophrenic sinus. In order to obtain an adequate drainage, at least a 24 gauge (Ch) chest tube is recommended.

#### Comments

Requirements to treat a post pneumonectomy empyema include an early drainage of the intrathoracic space, closure of the BPF and creation of an open thoracostomy, which is usually packed with medicated swabs and, eventually, closed (5-7). Rarely, the drain alone is sufficient to allow the fistula to close by itself; however, a conservative management of the BPF has shown to be effective in case of small fistulae (8). Furthermore, drainage of the empyema through chest tube alone, not followed by an open window thoracostomy, may be an appropriate compromise to those impaired patients who, due to their condition, (compromised lung function tests, limited cardiopulmonary reserve, impaired general condition, early cancer recurrence, chest wall deformities such as scoliosis, small fistulas, etc.) may not withstand it.

The need of early chest cavity drainage is mandatory to

prevent a mediastinal hypertensive shift and contralateral inhalation pneumonia. However, cardiac dislocation, diaphragm and abdominal organ raising and massive subcutaneous emphysema could make this manoeuvre hazardous and unsafe.

In addition, the tip of the drainage tube should be positioned in the deepest part of the cavity where secretions and potentially infected fluid may stagnate. The main advantage of the proposed technique is to drain the deepest part of the pleural cavity, entering the chest in a safe position distal to mediastinal, vascular, diaphragmatic and abdominal structures (*Figure 1C*).

Our technique is based on the so-called "siphon principle": a siphon is a continuous tube that allows liquid to drain from a reservoir (chest cavity) through an intermediate point (insertion point of the drainage tube on the skin) located higher than the reservoir, the flow (pleural fluid) being driven only by the difference in hydrostatic pressure without the need of a pump. The end tip of the tube (the collection chamber) must be lower than the liquid surface in the reservoir (9).

This technique also permits an even irrigation and drainage of the chest cavity by means of another small apical tube (*Figure 2A*), in order to improve the cavity drainage, cleansing and obtain control of the empyema.

#### **Acknowledgements**

None.

# Footnote

*Conflicts of Interest*: The authors have no conflicts of interest to declare.

*Informed Consent:* Informed consent obtained at admission of the patient.

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**Cite this article as:** Petrella F, Sandri A, Rizzo S, Borri A, Galetta D, Gasparri R, Spaggiari L. Emergency drain for post pneumonectomy bronchopleural fistula: a drain placement technique based on the siphon principle. J Thorac Dis 2018;10(1):468-471. doi: 10.21037/jtd.2017.11.145

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