

Imaging the Post-Thoracotomy Patient

Anatomic Changes and Postoperative Complications

Jeffrey B. Alpert, MD^{a,*}, Myrna C.B. Godoy, MD, PhD^b,
Patricia M. deGroot, MD^b, Mylene T. Truong, MD^b,
Jane P. Ko, MD^a

KEYWORDS

- Thoracotomy • Lobectomy • Pneumonectomy • Postpneumonectomy
- Postoperative complications • Bronchopleural fistula • Empyema

KEY POINTS

- Thoracotomy is used for lobectomy and pneumonectomy and produces expected postsurgical anatomic and physiologic changes. Distorted postsurgical anatomy can be challenging for the radiologist, but often follows typical patterns.
- Complications following thoracotomy and lung resection can occur in both the early and late postoperative settings. Although some are relatively benign, other complications produce significantly increased morbidity and mortality.
- Physiologic changes are associated with postpneumonectomy pulmonary edema, and anatomic changes can predispose to lobar torsion and cardiac herniation. These early postoperative complications are associated with devastating clinical outcomes if not recognized in a timely fashion.
- Bronchopleural fistula and empyema are 2 serious complications of lung resection that can occur in the early or late postoperative setting; treatment of both can be challenging.

INTRODUCTION

With increasing use of thoracoscopic and minimally invasive surgery for lung resection, thoracotomy is typically reserved for procedures that require a larger surgical field, such as lobectomy and pneumonectomy. An understanding of the expected post-thoracotomy appearance of the chest is essential, as postoperative complications can make imaging findings additionally complex. Accurate identification and timely diagnosis of complications is crucial in minimizing increased morbidity and mortality.

The objectives of this article are to review the expected appearance of the thorax after lung resection, as well as several postsurgical complications, using both radiography and multidetector-row computed tomography (MDCT).

PULMONARY RESECTION

Lung resection is most frequently performed for the surgical treatment of bronchogenic carcinoma. Lobectomy is well established as the standard of care for curative resection in patients with early-stage non-small cell lung cancer, whereas

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^a Thoracic Imaging, Department of Radiology, NYU Langone Medical Center, 660 First Avenue, 7th Floor, New York, NY 10016, USA; ^b Department of Diagnostic Imaging, The University of Texas, MD Anderson Cancer Center, 1515 Holcombe Boulevard, Unit Number 1478, Houston, TX 77030, USA

* Corresponding author.

E-mail address: Jeffrey.Alpert@nyumc.org

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pneumonectomy is more appropriate in patients with lung cancer who have multilobar or central disease.¹⁻³ The use of sublobar lung resection, such as wedge or segmentectomy, for early-stage lung cancer has been a popular topic of debate and is being performed more frequently.^{4,5} Although sublobar resection has traditionally been reserved for high-risk patients unable to tolerate lobectomy, multiple retrospective studies have shown results of sublobar resection similar to those of lobectomy among well-selected patients with early-stage disease,⁶⁻⁹ and a prospective clinical trial is currently under way to determine the efficacy of sublobar resection of small peripheral tumors.¹⁰ Lung resection is also indicated for end-stage lung disease related to advanced emphysema, and prior infection with resultant bronchiectasis. Pulmonary trauma may also lead to surgical resection.³

Partial Lung Resection

With the goals of adequate treatment and preservation of maximum lung function, limited lung resection such as wedge resection, segmentectomy, and lobectomy is performed when possible. Such resection is often achieved with thoracoscopy rather than open thoracotomy, although the selection of surgical approach ultimately depends on the extent of disease, its anatomic distribution, and the clinical status of the patient.

Nonanatomic wedge resection is a U-shaped or V-shaped resection with removal of lung that does not correspond to a lobar segment; the segmental bronchus and pulmonary artery typically remain, although the lung parenchyma is distorted. In segmentectomy, the segmental pulmonary bronchus and pulmonary artery are ligated and transected, with removal of the corresponding lung segment. Similarly, lobectomy includes isolation and transection of the lobar airway and artery, with removal of the lobe and its surrounding pleura. In cases of incomplete interlobar fissures, staple lines may be used to prevent postsurgical air leak.

In cases of central endobronchial tumor, sleeve lobectomy can be performed to avoid pneumonectomy. This procedure includes en bloc resection of the diseased lung and a portion of the common airway, with careful end-to-end anastomosis of the transected airway. Vascularized tissue such as pleura or omentum is typically wrapped around the bronchial anastomosis for reinforcement.¹¹ Sleeve lobectomy is most commonly used for right upper lobe resection (75%), owing to the longer length of the bronchus intermedius for anastomosis. Sleeve resection of the left upper and lower lobes is performed less

commonly (16% and 8% of cases, respectively) because of the close proximity of the airway ostium and the adjacent pulmonary artery.¹¹

Common radiographic findings in a patient following limited lung resection such as lobectomy include surgical material and volume loss (**Fig. 1**). Volume loss is indicated by elevation of the hemidiaphragm on the side of surgery, and increases as the degree of lung resection increases. The heart and mediastinum may also shift into the postsurgical hemithorax. It is often difficult to determine the full extent of lung resection on radiographs: the remaining ipsilateral lung shifts to fill the vacant surgical space, compensatory overinflation may occur, and anticipated anatomic landmarks become distorted.

MDCT allows improved characterization of resultant postsurgical changes with high spatial resolution in 3 dimensions, best achieved by reconstructing thin-section images that facilitate multiplanar reformatted imaging. On computed tomography (CT), the presence of surgical material and changes in central lung anatomy are key to determining the type and location of limited lung resection. A peripheral suture line with intact segmental bronchi and vessels should suggest wedge resection, whereas central surgical clips and ligated bronchi and vessels indicate segmentectomy or lobectomy (**Figs. 2 and 3**).

Pneumonectomy

Among patients with multilobar or central disease, pneumonectomy is typically performed.³ The most

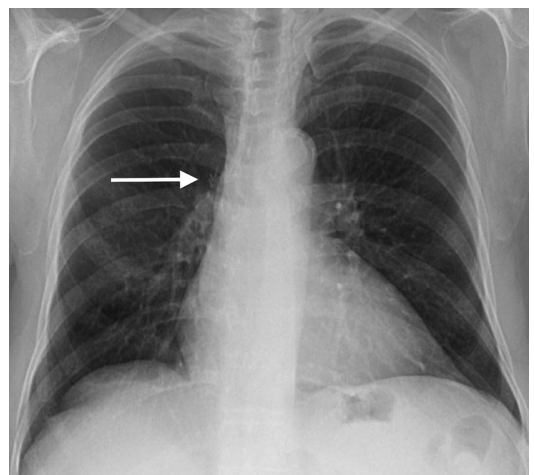


Fig. 1. Posteroanterior chest radiograph demonstrating right upper lobectomy. There is right-sided volume loss, and surgical clips are seen at the right hilum (*arrow*). The hyperinflated right middle and lower lobes have shifted to occupy the vacant surgical space.

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