Thoracotomy Pneumonectomy

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Introduction

Pneumonectomy is performed for lung tumors that are centrally located and preclude sleeve resection with a clear margin, separate primary tumors in the ipsilateral upper and lower lobes, or invasive infections unresponsive to long-term antibiotic therapy with significant parenchymal destruction and/or massive hemoptysis. Carinal pneumonectomy for tumors involving the carina or proximal mainstem bronchus and extrapleural pneumonectomy for malignant mesothelioma are addressed elsewhere in this volume. Pneumonectomy was performed in only 6 % (n = 1,132) of the 18,800 patients who underwent lung resection for cancer in the Society of Thoracic Surgeons (STS) database from 2002 to 2008 (Kozower et al. 2010). From 2002 to 2007, 1,267 patients over 18 years of age underwent pneumonectomy for both benign and malignant disease. Of these procedures, 74 % were de novo standard pneumonectomies, with 36.1 % performed on the right side, 46.8 % on the left, and 17.1 % with no laterality noted (Shapiro et al. 2010). The morbidity rate for pneumonectomy was 30.4 %, with a 5.6 % mortality rate.

Preoperative evaluation for pneumonectomy involves testing to predict respiratory function and perioperative risk after removal of a whole lung. Basic pulmonary function tests include spirometry, lung diffusion of carbon monoxide (DLCO), and arterial blood gas levels. Predicted postoperative FEV_1 (forced expiratory volume in the first second of expiration) and DLCO greater than 40 % establishes acceptable risk for lung resection without further testing. Results below this level prompt more rigorous determinations of adequate pulmonary function after pneumonectomy. Nuclear lung perfusion studies quantify differential function between the left and right lungs. Cardiopulmonary exercise testing determines the combined cardiac and respiratory reserve by measuring the maximum oxygen uptake (Vo_2max). Lower values of Vo_2max have been correlated with higher mortality and complication risk after lung resection. Patients with a Vo_2max greater than 15–20 µg/kg/min can generally tolerate a pneumonectomy, whereas those with a Vo_2max between 10 and 15 µg/kg/min have increased risks (Colice et al. 2007).

The most common perioperative complications are listed in Table 14.1. Postpneumonectomy pulmonary edema or acute lung injury has been documented in 4–8 % of pneumonectomy patients (Dulu et al. 2006; Ruffini et al. 2001).

Independent risk factors for developing perioperative complications are age greater than 65 years, male sex, pneumonectomy for benign disease, and congestive heart failure. Current smoking, right-sided pneumonectomy, and neoadjuvant radiation therapy have been problems in some reports but were not significant using data from the STS general thoracic database. Unfortunately, outcomes based on pulmonary function were not predicted from this database because of missing spirometry data.

Pneumonectomy traditionally has been performed by thoracotomy, but minimally invasive approaches are gaining popularity at specialized centers and are discussed in Chap. 15. After adequate attainment of single-lung ventilation, the first step in any pneumonectomy is ensuring the feasibility of complete (R0) resection and the absence of occult metastatic disease in the ipsilateral chest. The pleura is opened to expose the hilar bronchovascular anatomy to confirm operability, and the need for intrapericardial vascular division is determined.

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Table 14.1 Complications after pneumonectomy in 1,267 patients in the STS general thoracic surgery database from 2002 to 2007

Complication	Incidence (%)
Atrial arrhythmia	20.2
Reintubation	5.6
Pneumonia	4.6
Adult respiratory distress syndrome	3.1
Tracheostomy	2.5
Ventilator support >48 h	2.1
Sepsis	1.7
Reoperation for bleeding	1.5
Ventricular arrhythmia	1.0
Bronchopleural fistula	0.8
Pulmonary embolus	0.8
Myocardial infarction	0.8
Central neurologic event	0.6
Empyema	0.6

Data from Shapiro et al. (2010)

Figure 14.1

A muscle-sparing posterolateral thoracotomy is performed in the fifth intercostal space. Division or shingling of the posterior sixth rib allows optimal spreading of the ribs (see Chap. 2). The chest is explored thoroughly for metastatic disease and confirmation that hilar dissection is possible with grossly clear margins either within or outside the pericardium. The inferior pulmonary ligament is divided

Figure 14.2

Any lymph nodes visualized are dissected and sent for pathologic analysis. If intrapericardial dissection is necessary, the pericardium is opened on the hilar side of the phrenic nerve and extended from the pericardial reflection from the inferior vein to the pericardial reflection at the superior portion of the pulmonary artery (*PA*). The inferior pulmonary vein (*PV*) is dissected circumferentially

Figure 14.1

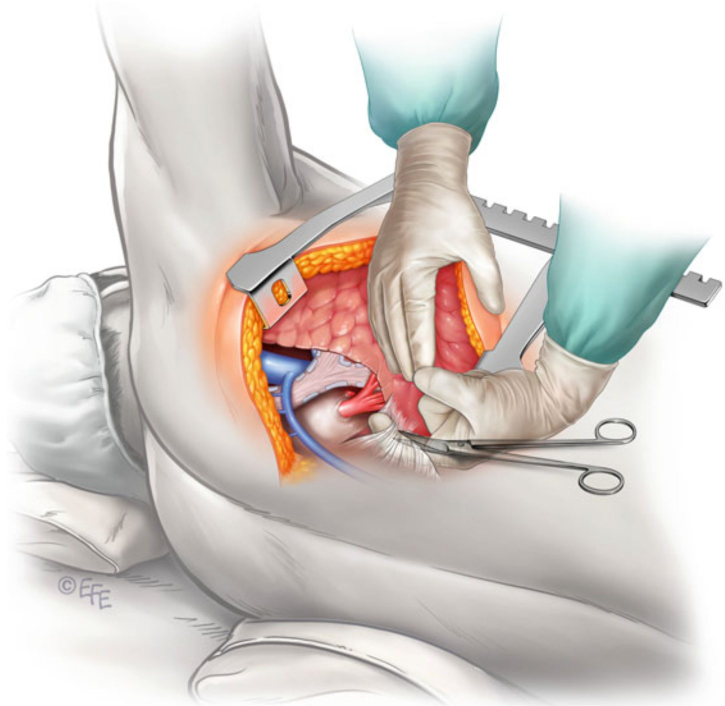


Figure 14.2

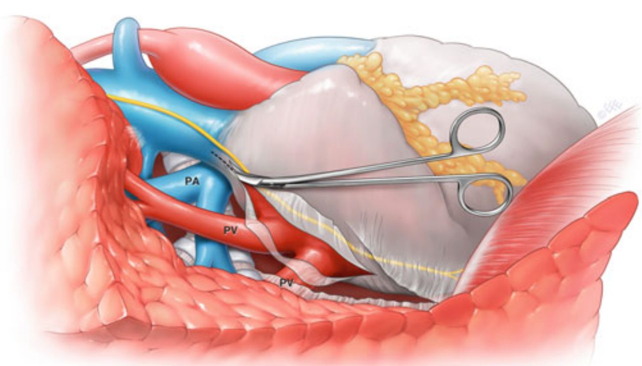


Figure 14.3

A vessel loop or tie may be passed if desired

Figure 14.4

The superior pulmonary vein is dissected circumferentially, and a vessel loop is passed if desired to help facilitate ligation. The inferior and superior pulmonary veins are ligated and divided with either transfixing sutures and scissors or cutting staplers. Circumferential dissection of the main pulmonary artery is performed, and a vessel loop is passed twice to allow occlusion of the pulmonary artery

Figure 14.3

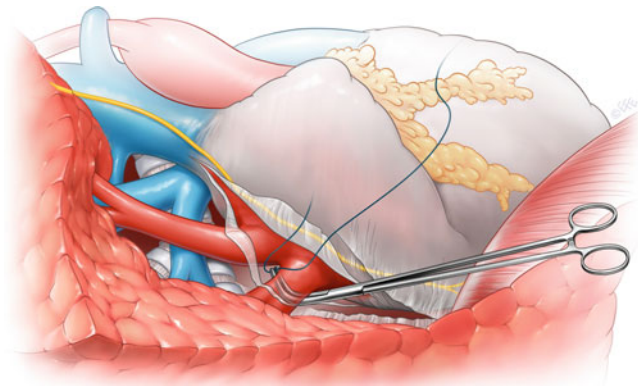


Figure 14.4

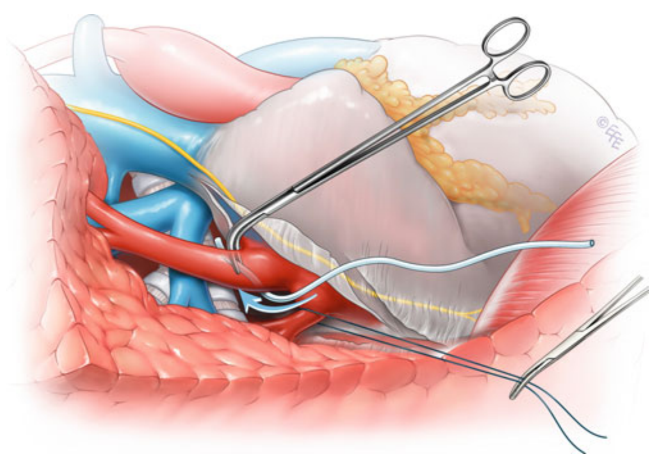


Figure 14.5

After the pulmonary artery is occluded for approximately 1 min, hemodynamic and respiratory stability are confirmed. The artery is then ligated and divided with a transfixing suture or vascular stapler

Figure 14.6

The mainstem bronchus is dissected from the proximal stump of the pulmonary artery, vagus nerve, and esophagus on either side until the contralateral mainstem bronchus is palpated, indicating dissection to the carina. Any subcarinal or tracheobronchial lymph nodes encountered are dissected and sent for permanent section. The mainstem bronchus is retracted out of the hilum gently to allow placement of a stapler or bronchus clamp as flush to the carina as possible. The anesthesiologist withdraws the bronchial lumen of the double-lumen endotracheal tube into the trachea prior to clamping the bronchus if it was positioned in the ipsilateral bronchus. If desired, a bronchoscope may be passed through the endotracheal tube to check the length of the stump while confirming that there is no issue with ventilation to the contralateral lung prior to division. Routine lymph node dissection is performed after bronchial closure. The lung is passed off the table for histologic or culture analysis

Figure 14.5

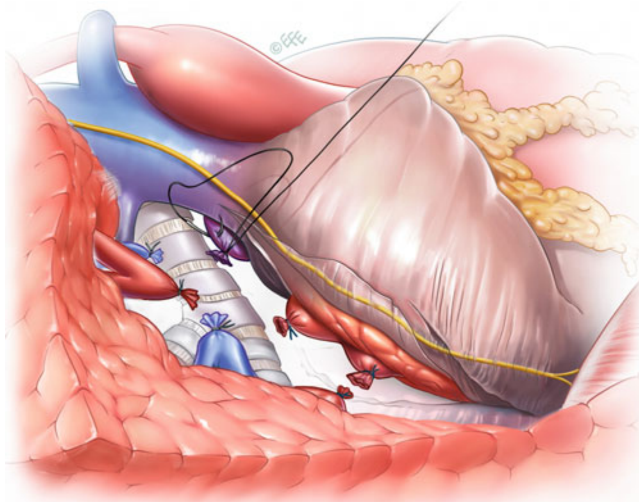


Figure 14.6

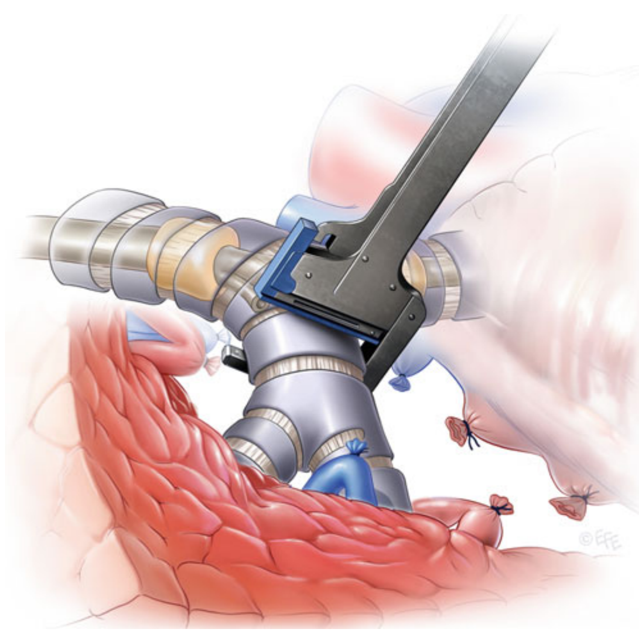
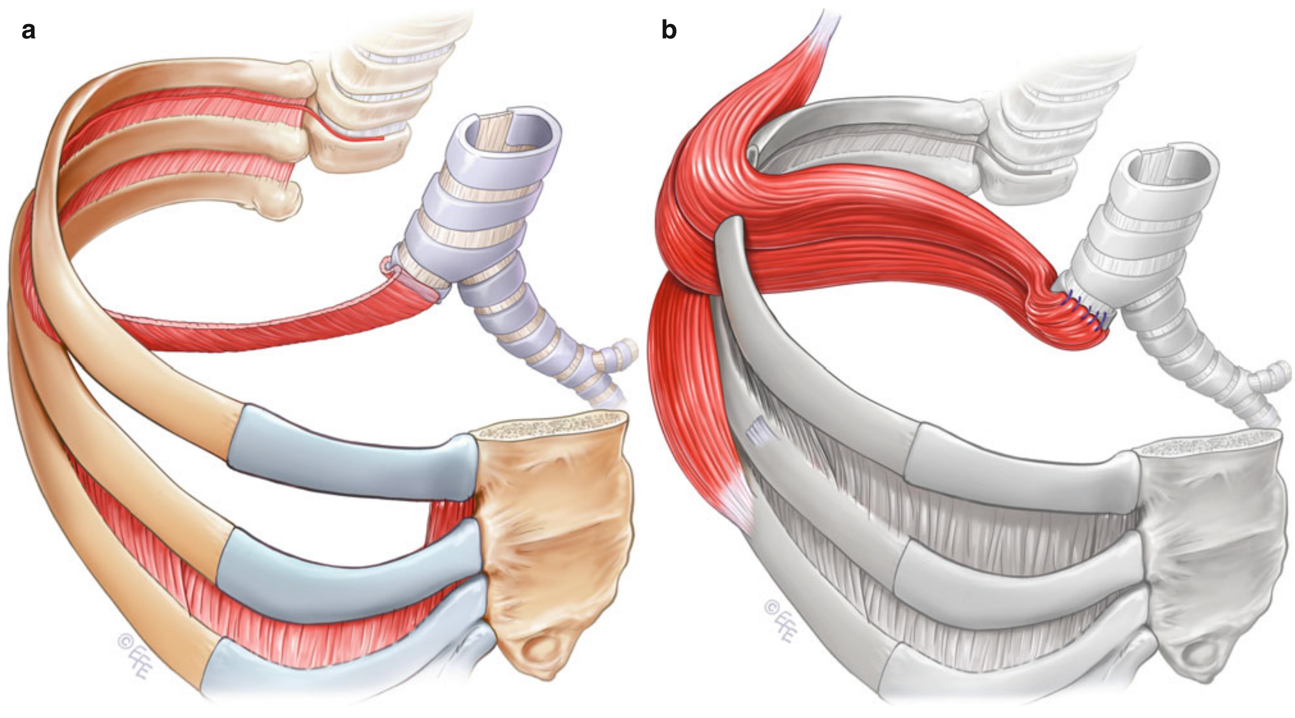


Figure 14.7

(**a**, **b**) The bronchial stump is covered further with a pedicled pleural, pericardial, or muscle flap (usually intercostal (**a**) or serratus anterior (**b**) if its healing may be compromised by neoadjuvant or adjuvant therapy, inflammation, or infection

Figure 14.7



Conclusion

Thoracotomy pneumonectomy is a low-mortality procedure for removing cancer or infection. Anatomic dissection of the bronchovascular structures of the hilum may be performed extra- or intrapericardially to obtain a clear margin. Almost one third of patients who undergo pneumonectomy have a postoperative complication that is predominantly cardiorespiratory in nature. If parenchyma-sparing sleeve resection can be performed, this should take precedence over pneumonectomy.

Postpneumonectomy pleural space drainage remains controversial with regard to presence, duration, and system. Proponents believe drainage should be used (1) to monitor blood loss, (2) to equalize intrathoracic pressure changes, (3) to prevent postpneumonectomy pulmonary edema, and (4) to allow drainage of microbial organisms if there was pleural infection or contamination during pneumonectomy (Deslauriers and Gregoire 1999; Mattioli et al. 2008; Pecora 1973; Shah et al. 2002; Walker 2002; Weissberg 2002). A balanced drainage system meets all these requirements. Challengers do not subscribe to any or all of the aforementioned reasons and may choose to not leave any drainage tubes without a proven complication. The thoracotomy is closed in layers, and the pleural space will fill with fluid gradually. Mild subcutaneous emphysema may develop as the air inside the pleural cavity is displaced by pleural fluid. However, suspicion of bronchial stump leakage should be triggered by florid subcutaneous emphysema. Although not proven conclusively, adequate pain control after thoracotomy pneumonectomy may reduce the incidence of complications (Ballantyne et al. 1998; Bauer et al. 2007; De Cosmo et al. 2009; Hazelrigg et al. 2002; Liu and Wu 2007).

References

Ballantyne JC, Carr DB, deFerranti S, Suarez T, Lau J, Chalmers TC et al (1998) The comparative effects of postoperative analgesic therapies on pulmonary outcome: cumulative meta-analyses of randomized, controlled trials. Anesth Analg 86(3):598–612

Bauer C, Hentz JG, Ducrocq X, Meyer N, Oswald-Mammosser M, Steib A et al (2007) Lung function after lobectomy: a randomized, double-blinded trial comparing thoracic epidural ropivacaine/sufentanil and intravenous morphine for patient-controlled analgesia. Anesth Analg 105(1):238–244

Colice GL, Shafazand S, Griffin JP, Keenan R, Bolliger CT, American College of Chest Physicians (2007) Physiologic evaluation of the patient with lung cancer being considered for resectional surgery: ACCP evidenced-based clinical practice guidelines (2nd edition). Chest 132(3 Suppl):161S–177S

De Cosmo G, Aceto P, Gualtieri E, Congedo E (2009) Analgesia in thoracic surgery: review. Minerva Anestesiol 75(6):393–400

Deslauriers J, Gregoire J (1999) Techniques of pneumonectomy. Drainage after pneumonectomy. Chest Surg Clin N Am 9(2):437–448, xii

Dulu A, Pastores SM, Park B, Riedel E, Rusch V, Halpern NA (2006) Prevalence and mortality of acute lung injury and ARDS after lung resection. Chest 130(1):73–78

Hazelrigg SR, Cetindag IB, Fullerton J (2002) Acute and chronic pain syndromes after thoracic surgery. Surg Clin N Am 82(4):849–865

Kozower BD, Sheng S, O'Brien SM, Liptay MJ, Lau CL, Jones DR et al (2010) STS database risk models: predictors of mortality and major morbidity for lung cancer resection. Ann Thorac Surg 90(3):875–881; discussion 881–883

Liu SS, Wu CL (2007) The effect of analgesic technique on postoperative patient-reported outcomes including analgesia: a systematic review. Anesth Analg 105(3):789–808

Mattioli S, Berrisford RG, Lugaresi ML, Aramini B (2008) Survey on chest drainage systems adopted in Europe. Interact Cardiovasc Thorac Surg 7(6):1155–1159

Pecora DV (1973) Management of the post pneumonectomy pleural space. Surg Clin N Am 53(3):623–626

Ruffini E, Parola A, Papalia E, Filosso PL, Mancuso M, Oliaro A et al (2001) Frequency and mortality of acute lung injury and acute respiratory distress syndrome after pulmonary resection for bronchogenic carcinoma. Eur J Cardiothorac Surg 20(1):30–36; discussion 36–37

Shah T, Sharma R, Mehta H, Rau R, Solanki P (2002) Another indication for chest tube after pneumonectomy. Tex Heart Inst J 29(3):232

Shapiro M, Swanson SJ, Wright CD, Chin C, Sheng S, Wisnivesky J et al (2010) Predictors of major morbidity and mortality after pneumonectomy utilizing the Society for Thoracic Surgeons General Thoracic Surgery Database. Ann Thorac Surg 90(3):927–934; discussion 934–935

Walker WE (2002) Hazards of chest tubes after pneumonectomy. Tex Heart Inst J 29(1):72; author reply 72–73

Weissberg D (2002) Post-pneumonectomy chest tubes. Tex Heart Inst J 29(2):155