Extended Resections of Non-small Cell Lung Cancers Invading the Aorta, Pulmonary Artery, Left Atrium, or Esophagus: Can They Be Justified?

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KEYWORDS

• Non-small cell lung cancer • T4 • Aorta • Pulmonary artery • Left atrium • Esophagus
• Extended resection

KEY POINTS

- T4 tumors that invade the heart, great vessels, or esophagus comprise a heterogenous group of locally invasive lung cancers.
- Prognosis depends on nodal status.
- Resection should be considered in relation to multidisciplinary care.
- Notable improvements in imaging, surgical techniques, and perioperative care during the past several decades have resulted in an increase in survival for highly selected patients.

INTRODUCTION

Surgical resection remains a critical component of multidisciplinary therapy for locally advanced lung cancers. Non-small cell lung cancers (NSCLC) are highly lethal neoplasms, particularly when diagnosed in advanced stage. More than 50% of NSCLC patients present with metastatic disease or tumors that are unresectable.[1] In stage I NSCLC, for which surgery provides the best chance for cure, overall 5-year survival rates following resection range from 75% to 65% for stage IA and IB tumors, respectively.[2] This rate is in comparison to 5-year survival rates of 24% for stage IIIA and 9% for stage IIIB (T4N2M0) disease.[3] The therapeutic approach for advanced stage NSCLC is controversial, particularly in the surgical management of a subset of T4 tumors invading the heart, great vessels, and other mediastinal structures. However, with modern advances in imaging, surgical techniques, and perioperative care, extended resections may improve survival for highly selected patients.

HISTORICAL BACKGROUND

With the advent of cardiopulmonary bypass (CBP) in the late 1950s, surgeons realized the potential for extracorporeal circulation to facilitate resection of pulmonary malignancies involving the great vessels or atria. In 1965, Neville and colleagues[4] reported a series of 6 patients with lung cancer in whom CPB was used during carinal resection or sleeve lobectomy. One more patient underwent left intrapericardial pneumonectomy with resection and interposition graft repair of the

Disclosures: None.
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Thorac Surg Clin 24 (2014) 457–464
http://dx.doi.org/10.1016/j.thorsurg.2014.07.012
1547-4127/14/$ – see front matter Published by Elsevier Inc.

descending aorta. Disappointingly, 6 of the 7 patients died in the immediate postoperative period from bleeding, heart failure, or pulmonary edema. Several years later, Bailey and colleagues[5] described 2 patients with lung cancer in whom CPB was used to facilitate extended left pneumonectomy. The first patient required left intrapericardial pneumonectomy with en bloc resection and direct suture repair of the left atrium as well as resection and interposition graft repair of the descending aorta. The second patient underwent left intrapericardial pneumonectomy, resection and repair of the left atrium, and resection and repair of the distal main pulmonary artery. Both patients were fully heparinized and cannulated for venous return via the main pulmonary artery, and arterial inflow by 2 sites in the aorta, proximal and distal to the lines of surgical resection. The first patient developed coagulopathy and died in the early postoperative period. The second patient, whose pathologic stage by description was T4N1, survived 14 months before succumbing to metastatic disease. Although sophisticated staging systems and prognostic indicators for lung cancer had not yet been developed, the aforementioned authors understood the principles of en bloc tumor resection with minimal manipulation, the significance of tumor histology and mediastinal lymph node metastases, and the consequences of coagulopathy complicating pneumonectomy.

MORE RECENT EXPERIENCE

The value of surgical resection for the treatment of T4 NSCLCs invading the aorta, pulmonary artery, left atrium, and esophagus remains open to debate. Presently, most patients are not offered resection in part because of the potential for significant morbidity and mortality. However, perioperative risk in this subset of patients has improved over time (**Table 1**). In 1987, Burt and colleagues[6] published a retrospective review of 225 patients who underwent thoracotomy for primary NSCLC invading the mediastinum. Lesions were classified as T3, "a tumor of any size with direct extension into an adjacent structure such as the mediastinum and its contents," according to TNM descriptors used by the Union for International

Table 1
Selected summary of extended resections of T4 NSCLC

Reference	T4 Sites of Disease	Patients	Morbidity (%)	Mortality (%)	Overall Survival (% at 5 y)
Burt et al,[6] 1987	Aorta, pulmonary artery, esophagus	225	NR	2.7	9
Tsuchiya et al,[7] 1994	Aorta, left atrium, pulmonary artery, SVC	101	NR	NR	13
Martini et al,[8] 1994	Aorta, left atrium, pulmonary artery, SVC, esophagus, trachea, spine	102	NR	6	19
Bernard et al,[9] 2001	Aorta, left atrium, pulmonary artery, SVC, esophagus, carina, spine	77	NR	NR	21[a]
Pitz et al,[10] 2003	Aorta, left atrium, pulmonary artery, SVC, esophagus, trachea, carina, spine	89	NR	19	19
Ratto et al,[11] 2004	Left atrium	19	37	0	14
Ohta et al,[12] 2005	Aorta	16	31	12.5	48
Yildizeli et al,[13] 2008	Aorta, left atrium, pulmonary artery, SVC, esophagus, carina, spine, subclavian artery/vein, carotid artery, chest wall	271	35	4	38
Wu et al,[14] 2009	Left atrium	46	52	0	22
Yang et al,[15] 2009	Aorta, left atrium, pulmonary artery, SVC, esophagus, trachea, carina, spine	146	53	3.1	23
Spaggiari et al,[16] 2013	Aorta, left atrium, SVC, carina	167	34	5	23
Galvaing et al,[17] 2014	Left atrium	19	53	11	44

Abbreviation: NR, not recorded.
[a] Survival rate at 3 years.

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