



Surgical treatment for locally advanced lung cancer involving the heart and great vessels: a mini-review

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Abstract: Currently, there is no unanimous agreement about the indications of surgical treatment for locally advanced lung cancer, particularly when the heart and the great vessels are involved. Though generally not considered indicated in these cases, surgery can be offered to highly selected patients when a radical resection is considered achievable, and neither distant nor nodal metastasis are present. Throughout the last few decades, many authors have explored the possibility for surgical resection of lung cancer involving the heart and/or the great vessels [thoracic aorta, pulmonary artery, superior vena cava (SVC)]. In this article we consider their experiences focusing on the technical aspects of the vascular reconstruction.

Keywords: Lung cancer; surgery; heart; great vessel

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Introduction

Non-small cell lung cancer (NSCLC) involvement of neighboring structures, particularly the heart and great vessels, is classically considered a relative contraindication for surgical treatment, mainly due to technical considerations, difficulties in achieving a radical resection, concerns regarding perioperative morbidity and mortality, and poor oncological outcomes. However, many authors in the last few decades have reported encouraging short-term and long-term results in selected patients undergoing lung resection extended to cardiovascular structures. These include the heart (mainly the left atrium), the superior vena cava (SVC), the pulmonary arteries and the thoracic aorta.

Pulmonary artery

The advantages of pulmonary artery reconstruction after resection for lung cancer involvement are well established. It allows to avoid pneumonectomy thus

preserving respiratory function, and it has comparable oncological results with standard lobectomy (1). It might as well be associated with bronchoplastic procedures (2). The choice of the particular reconstruction technique is made intraoperatively on the basis of the extent of vascular involvement. It can be performed by tangential excision with primary suture, usually when less than 25% of the vascular circumference is involved (3). If a larger portion of the vessel is involved, up to half of the circumference, reconstruction may be carried out by partial resection and positioning of a patch to fill the gap; patches may be in autologous, bovine or porcine pericardium, or autologous pulmonary vein. If more than half of the circumference is involved by the tumor, circumferential resection is performed with end-to-end anastomosis or, if the resected segment is too long, interposition of a prosthetic conduit in pericardium or pulmonary vein (4,5). While pulmonary artery sleeve resection has become a relatively common indication in thoracic surgery, resection of the bifurcation of the main pulmonary artery has also been described with the

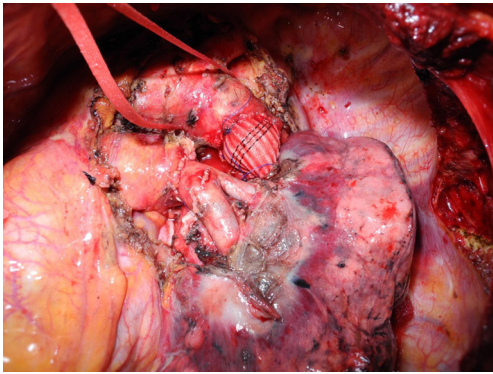


Figure 1 Intraoperative picture illustrating the aortic arch reconstructed with a Dacron patch.

use of cardiopulmonary bypass (CPB), but the indication remains unclear (6,7).

SVC

Resection and reconstruction of the SVC is a complex procedure (8). Lung cancer invading the SVC frequently involves the bronchial tree, especially the carina, and lobectomy with bronchoplasty or pneumonectomy is frequently necessary to resect such tumors. The SVC might as well be infiltrated by metastatic nodes and this is a negative prognostic factor compared to direct primary tumor invasion (9). Clamping of the SVC leads to an increase of the venous pressure in the cephalic district, with the risk of complications such as intracranial bleeding, cerebral edema and severe reduction of cardiac output, therefore care must be taken in intraoperative management. While clamping of a chronically occluded SVC is better tolerated hemodynamically, it is less likely to be eligible for radical surgery, so patient selection is crucial. Intraoperative management for reducing the risk of hemodynamic imbalance includes fluid implementation via venous catheter in the lower limbs, vasoconstrictive agents, and reducing the clamping time as much as possible. Intravascular or extravascular shunts may be used to reduce the effects of vascular clamping. Intraoperative and post-operative heparinization is mandatory to avoid thrombotic complications. According to the extent of the vascular involvement, the SVC reconstruction can be performed by tangential resection and direct suture or interposition of an autologous or bovine pericardial patch, but the most common procedure is the replacement with a prosthetic conduit, usually in PTFE or autologous/bovine pericardium

(10,11). When the confluence of the innominate veins is infiltrated by the tumor, the preference is to revascularize only one innominate vein, usually the left (12).

Thoracic aorta

En bloc resection of lung cancer invading the thoracic aorta is another debated issue (13). It is a very delicate and complex procedure and many techniques have been described (14). Although difficult to achieve, radical resection allows good oncological results with reasonable morbidity and mortality rates. The choice of the reconstruction technique is based on the site of invasion (aortic arch or descending aorta), on the circumferential extent and on the depth of the vascular wall involvement. If the aortic infiltration is locally confined to the adventitia and a plane of dissection within the aortic wall can be easily developed, a subadventitial dissection can be conducted after having encircled the aorta below and over the infiltrated area for eventual emergency clamping. When there is evident or suspected invasion of the media layer of the aorta, and more than approximately 30% of aortic circumference is involved by the tumor, different approaches can be used: direct aortic clamping with aortic wall resection and reconstruction particularly in cases with vascular involvement located at the level of the descending aorta (15). Partial CPB between the femoral vein and femoral artery or a temporary bypass graft from the ascending aorta to the descending aorta can be performed in cases of aortic arch involvement, with the possibility of reconstruction of an infiltrated subclavian artery or carotid artery (16). Alternatively, more recently the pre- or intraoperative aortic endograft placement and aorta/aortic arch resection by the cross-clamping technique have successfully been applied to allow a safe aortic wall dissection, avoiding the use of CPB (17,18) (*Figure 1*).

Heart

Although lung cancer with cardiac involvement is usually considered not eligible for surgical treatment, it has occasionally been performed when complete resection was deemed possible and no distant metastasis were present. The indication remains controversial given the very small number of cases reported in literature (6,7,19-25). The majority of described cases concerns left atrium resection. For anatomic reasons, right side tumors can invade the left atrium faster than left tumors because of shorter pulmonary

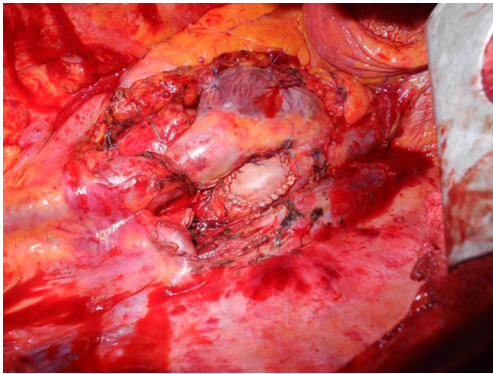


Figure 2 After lung cancer infiltrating the left atrium has been resected, a bovine pericardial patch reconstruction was performed.

veins. Moreover with left tumors quick multiorgan infiltration (left atrium, aorta, esophagus, etc.) is more common, thus precluding the surgical option. Cardioplegia or fine ventricular fibrillation, used in conjunction with CPB, enables safe opening of the cardiac chambers, which facilitates complete resection of the tumor. Some authors (19,24,25) have described the use of the Sondergaard technique for dissection of the interatrial groove, which allows to lengthen the left atrial cuff, which is then safely clamped, allowing left atrial resection without the use of CPB; the atrial defect can then be directly sutured or a pericardial patch can be interposed to reconstruct the atrial wall (*Figure 2*).

CPB

Some of the complex cardiovascular reconstruction procedures described involve the use of CPB. CPB associated with extended lung resection for cancer has been introduced a long time ago (26), but despite technical advances there are very few cases described, both for a reluctance of surgeons to embrace an aggressive approach to locally advanced lung cancer, and for the concern of major perioperative complications such as bleeding. Interestingly, a meta-analysis from Muralidaran and colleagues (27) concluded that planned use of CPB gives the best survival benefit compared to its use in an emergency setting for intraoperative complications. In addition, there is the theoretical concern that a combination of CPB-mediated immunosuppression and direct mechanical dissemination could result in systemic spread of the disease during pulmonary resection, though this has never been proved (28).

Conclusions

Tumors infiltrating the heart and the great vessels are a heterogeneous subset of T4 neoplasms, the treatment of which is still controversial. According to the latest ESMO guidelines (29), patients with biopsy proven T4N0 tumors (stage IIIA) are considered potential surgical candidates if R0 resection is considered to be achievable. The role of neoadjuvant chemotherapy or chemoradiotherapy is debated (30-32). However, the lack of sufficient randomized data leaves the choice of the treatment to the expertise of lung cancer multidisciplinary teams on a case-by-case basis. With modern advances in surgical techniques and perioperative care, current data suggest a significant improvement over the last few decades in morbidity and mortality of patients undergoing extended resection for tumors invading the thoracic aorta, the pulmonary artery, the SVC and the left atrium. Long-term survival results seem to justify such complex operations, which should therefore be offered to highly selected patients in experienced centers.

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