comparable to segmentectomy with regard to local recurrence rate and ultimate survival. Until the results of this Lung Cancer Study Group Trial are reported, surgeons should be cautious in recommending limited resection for patients suffering from lung cancer except in compromised individuals or those presenting with synchronous primary tumors.

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Extended Operations for T3–T4 Primary Lung Cancers*

Indications and Results

P. Dartorcelle, M.D.; J. Marselle, M.D.; A. Chapelier, M.D.; and F. Loch, M.D.

New surgical techniques allow resection of T3–T4 bronchogenic carcinomas involving adjacent structures, such as carina, superior vena cava (SVC), and thoracic inlet. Surgery remains the best treatment of such tumors, when compared to radiotherapy and chemotherapy; it provides relief of symptoms such as Pancoast syndrome, and may, in selected cases, lead to long-term disease free survival.

Tracheal Sleeve Pneumonecetmy (Fig 1)

From 1966 to 1986, 55 patients underwent tracheal sleeve pneumonectomy (33 right and 2 left) for bronchogenic carcinoma. Preoperative radiotherapy was given in only 5 patients. Tracheobronchial reconstruction was always performed through the same surgical approach. Tracheal sleeve pneumonectomy alone was performed in 37 patients. In the other 18 it was extended to the vena cava (4), left atrium (4) and lateratracheal lymph nodes (12).

The overall operative death rate was 10.9% but no patient died since 1975 (32 patients); 7 patients had an empyema (12.7%), and 4 associated with bronchopleural fistula. In the postoperative course, 25 patients had radiotherapy, 5 of whom had additional chemotherapy.

The actuarial survival rate, after exclusion of the 6

*From the Department of Thoracic and Vascular Surgery, Heart Lung Transplantation, Marie Lannelongue Hospital, Plessis Robinson, France.

Reprint requests: Dr. Dartorcelle, Association Marie-Lannelongue, 133 avenue de la Resistance, 92350 Le Plessis-Robinson, France

Figure 1. Technique of tracheal sleeve pneumonecetmy in bronchogenic carcinoma involving the proximal part of the right main bronchus.

Figure 2. Replacement of superior vena cava (SVC) using PTFE graft implanted between both ends of SVC. In lung cancer, the conflunce of the innominate veins is usually tumor free, allowing this simple procedure.
operative deaths, is 38% at 3 years and 23% at 5 years. Survival is correlated to regional lymph node involvement: in N1 patients the actuarial survival rate is 43% at 3 years; among the 13 patients staged N2 with only subcarinal involvement the actuarial survival rate is 34% at 3 years; none of the 8 patients with upper mediastinal lymph node involvement survived at 30 months.

Tracheal sleeve pneumonectomy for bronchogenic carcinoma with extension to the carina is now fully justified considering the low operative mortality rate and the good results observed when upper mediastinal lymph nodes are not involved. In addition, tumors involving more than 2 cm of the distal trachea should not be operated. A multifactorial study reviewing 1,285 pulmonary resections for bronchogenic carcinoma in our institution did not show any significant difference between the actuarial survival rate after resection for lobar cancers and for cancer involving the main bronchus, and further, among extended pneumonectomies, only tracheal sleeve pneumonectomy yielded an acceptable survival rate. We believe, like Deslauriers et al, that preoperative radiotherapy increases the risk of bronchopleural fistula.

**SUPERIOR VENA CAVA REPLACEMENT (Fig 2)**

From 1979 to 1987, 16 patients underwent superior vena cava (SVC) replacement using PTFE grafts combined with resection of mediastinal or pulmonary malignant tumors at our institution. Among them, 4 patients had en bloc resection of the SVC with bronchogenic carcinoma (N2 = 2 patients; N1 = 2 patients), whereas 12 patients had mediastinal malignant tumor (2 thymomas, 2 carcinoid tumors, 1 adenocarcinoma, 4 poorly differentiated tumors, 2 lymphoblastomas, and 1 endodermal sinus tumor).

In bronchogenic carcinoma, the prosthesis was always implanted between both ends of the SVC, because its origin is usually tumor free.

There was no operative death, and postoperative venacavograms demonstrated graft patency in all 4 patients. The 2 N2 patients died at 3 and 9 months, 1 N1 patient died at 36 months, and the other is alive at 32 months.

Invasion of SVC by lung cancer is usually limited, allowing partial resection and plasty using fresh pericardium. When total resection of SVC has to be performed, prosthetic replacement using PTFE is an easy procedure and may provide long-term survival. Radiotherapy and chemotherapy do not interfere with long term patency.

**COMBINED APPROACH OF SUPERIOR SULCUS TUMORS (Fig 3)**

Since 1980, 24 primary bronchogenic carcinomas (11 squamous cell, 9 adenocarcinomas, 3 mixed tumors and 1 small cell) with Pancoast syndrome were operated at our institution through a new surgical approach. The aim of surgery is to free brachial plexus from tumor and to resect as much of the tumor as possible: such a challenge can only be achieved through a combined procedure, i.e., a cervical approach with resection of the internal half of the clavicle and a posterolateral thoracic approach. In our series, the cervical approach was used in nearly one half of the cases to allow safe exposure of the superior sulcus. (1) subclavian artery was found involved by tumor in 11 patients (resection
of all branches 8 times, including vertebral artery once; resection of subclavian artery followed by PTFE bypass 3 times); (2) brachial plexus was freed from tumor in 18 patients: T1 (18 patients), C8 (10 patients), C7 (4 patients), C6 up to C4 (1 patient); (3) other structures, such as subclavian vein, vertebral artery, phrenic nerve, scalene muscles could not have been either safely freed from tumor or resected with sufficient tumor-free margin without the cervical approach.

Nine patients had a wedge resection of the tumor using an automatic stapler, 14 patients had lobectomy, and 1 patient had pneumonectomy. Operative mortality was 4.1%, 19 among the 23 survivors had postoperative radiotherapy, 2 of those with associated chemotherapy. Although long-term survival was poor (32% at 24 months), surgery provided a satisfactory and long-term relief of pain; 4 patients are alive without evidence of recurrence at 5, 17, 26, and 96 months.

Even though long-term survival is poor, surgery is still the best treatment of pain in Pancoast syndrome. In some cases in our series, surgery, even deemed palliative, together with postoperative radiation therapy, has provided long-term painless and disease-free survival.

CONCLUSION

While surgery remains the best treatment of bronchogenic carcinoma, new surgical techniques, ie, carinal reconstruction, prosthetic replacement of SVC, and combined approach of superior sulcus tumors, can be applied to T3-T4 tumors; the operative mortality is low, it provides satisfactory relief of symptoms, and gives much better results than surgery of N2 tumors.

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Bronchoplastic and Bronchovascular Procedures of the Tracheobronchial Tree in the Management of Primary Lung Cancer*

Takuo Naruke, M.D., F.C.C.P

Price Thomas performed the first sleeve lobectomy in a case of bronchial adenoma in 1947 and Allison the first bronchovascular procedure for bronchial carcinoma in 1952. Paulson and Shaw reported 9 cases of bronchoplasty for lung carcinoma in 1955 as a compromise operation for patients whose pulmonary reserve was inadequate to permit pneumonectomy. After these initial reports many others were published. Paulson and associates reported 54 cases of bronchoplasty performed in 1970, 8% of total lung cancer resection cases. Further, Jensik and associates reported 57 cases of bronchoplasty indicated for lung cancer cases in 1972. Bronchoplasty was already common in the US in these years.

In Japan bronchoplasty was reported for only 4 cases of lung cancer among the total 55 cases of bronchoplasty performed up to 1960. In 1968, the data collected for reported bronchoplasty in Japan were still only 7 cases of lung cancer of the total 77 cases of bronchoplasty performed. However, eventually the number of lung cancer cases for which bronchoplasty had been indicated increased. According to the total data collected in 1983, there were 929 lung cancer cases for which bronchoplasty applied, out of a total of 1,168 cases with indications for bronchoplasty. Since then this operative procedure is highly respected and is used increasingly nationwide.

Although there was broad application of this procedure, the number of central type of early stage lung cancer cases establishment of early detection system and advancement achieved in diagnostic technique, bronchoplasty is widely applied as a standard operative procedure, especially for central, early stage lung cancer.

INDICATIONS

The objectives of bronchoplastic and bronchovascular procedures for selected cases of lung cancer are preservation of lung tissue, improvement of curability, and extension of operative indication.

The procedures are indicated in the following circumstances: (1) tumor invasion from the lobar to the main bronchus; (2) pneumonectomy is not applicable for reasons of pulmonary function and others, but curable by this mode of operation; (3) curable by this mode of operation, even in cases of reserve of cardiopulmonary function; (4) preferable when tumor is limited to one lobe (applicable to any lobe); (5) when tumor invasion is within the range of reconstruction; (6) applicable even if unilateral mediastinal lymph node metastases are present; (7) preferable for squamous cell