Staging and Management of Lung Cancer: Sleeve Resection


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Sleeve lobectomy is a lung-saving procedure usually indicated for central tumors for which the alternative is a pneumonectomy. It preserves normal lung tissue and may enable pulmonary resection to be done in selected patients with inadequate cardiac or pulmonary reserve. Our experience extends from January 1972 to December 1991, during which time 142 patients underwent a variety of sleeve resections for bronchogenic neoplasms. The majority of operations were upper-lobe sleeve resections (N = 110) and most procedures were considered complete and potentially curative (87%). There were three postoperative deaths (surgical mortality of 2.5%) and prolonged atelectasis was the most common major complication (N = 9). Follow-up was complete for the 139 survivors (mean follow-up time of 2,149 days) and overall survival was 46% at 5 years and 33% at 10 years. Five- and 10-year survivals for patients with stage I disease were 63% and 52%, respectively, while only 14% of patients with stage III disease survived 5 years. Local recurrences occurred in 23% of patients but when the resection had been complete, this incidence was 17% (21/124). These results indicate that sleeve resection is an adequate cancer operation for both compromised and uncompromised patients.

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Price Thomas [1] was the first to report a case of bronchoplastic when, in 1947, he performed a bronchotomy with removal of a portion of the circumference of the wall of the right main bronchus for a carcinoid tumor. Price Thomas [2] also stated that it seemed reasonable to conserve as much pulmonary tissue as possible providing that by doing so, the patient’s expectation of survival was not materially altered as compared with that following a more extensive procedure. The next significant report on the use of bronchoplastic techniques was that of Paulson and Shaw [3] in 1955. They reviewed 18 patients in whom sleeve resection had been done for different reasons, including benign conditions, and they showed that by means of bronchial reconstruction, it was possible to excise the lesion while preserving a portion or all of the lung tissue distal to the point of excision.

In 1959, Johnson and Jones [4] analyzed long-term survival results after sleeve lobectomy carried out for lung cancer. They concluded that this technique was reasonably safe and that early follow-up results were certainly no worse than the results achieved by more conventional operations. Since then, many reports have suggested that sleeve resection accomplishes tumor and nodal clearance similar to that of pneumonectomy with the advantages of lower operative mortality rates, as-good-if-not-better survival rates for similar-stage tumors, and improved quality of life. Because of this, sleeve resection is now accepted as standard procedure even in patients with adequate pulmonary reserve.

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Indications for Sleeve Resection

Rationale for Operation in Lung Cancer Patients

In 1956, Nohl [5] studied the lymphatic and vascular spread of bronchogenic carcinoma in 100 specimens of resected lung tumors and he emphasized the predictability of upper-lobe lymphatic drainage. He showed that right upper-lobe lesions metastasize to nodes located just below the takeoff of the right upper-lobe bronchus and seldom involve nodes located below a line drawn for the middle-lobe bronchus to the apical bronchus of the lower lobe. He concluded that lobectomy, when technically feasible, is a sound procedure. Sleeve lobectomy of the upper lobe is an even more adequate cancer operation [6] because nodal clearance is as complete as is achieved with pneumonectomy except for those nodes located beyond the distal line of section of the bronchus, a form of lymphatic spread which, according to Nohl [5], is infrequent. Griess [7] also reported that proximal endobronchial extension of a bronchogenic carcinoma can extend to within 2 cm of the macro-

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scopic limits of bronchial resection, which further encourages the use of bronchoplastic techniques in the management of lung-cancer patients.

In 1986, Maeda et al. [8] reported on 47 patients who were pathologically studied in order to identify the kind of local tumor spread which may occur in lung cancer with particular reference to direct infiltration, intra- and peribronchial metastasis, and multifocality. They showed that lung cancer not only infiltrates around the primary tumor for a distance averaging 7.2 mm (range of 3-20 mm), but also that metastatic clusters of cancer cells are often found in the lymphatics, nodes, bronchial arterials, and nerve sheaths in the peri- and intrabronchial wall. In fact, lung cancer may have extensive peribronchial lesions—a feature which provides further rationale for the use of sleeve resections.

The use of lower-lobe sleeve resections with anastomosis of the upper lobe to the main bronchus is more difficult to justify both clinically and anatomically. In those cases, one must be extremely careful to identify possible metastatic nodes around the upper-lobe bronchus.

**Surgical Indications**

Sleeve resection is mostly indicated for cancer patients who could tolerate a pneumonectomy but in whom the lesion can be completely resected by a lesser bronchoplastic procedure. It is generally done for central lesions where the tumor cannot be removed by conventional lobectomy because the line of resection of the lobectomy would either transect the tumor or provide an inadequate margin. The use of sleeve resection when the carcinoma has spread to lobar or hilar nodes—N1 disease—remains an area of controversy although the results reported in some series [9] justify this approach when both tumor and nodes can be completely resected.

In some instances, the pulmonary artery is involved directly by the tumor, which cannot be removed without excising an elliptical portion of the artery itself or carrying out a full arterial sleeve resection (double-sleeve procedure). The role of this technique is unclear not only because the operative mortality is significantly higher than after bronchial sleeve resection alone [10] but also because there are few reports providing long-term survival data.

Sleeve resection may finally be indicated in patients considered compromised because of severe cardiac or respiratory impairment contraindicating pneumonectomy. In this group, however, perioperative mortality and incidence of bronchial disruption are higher and survival rates are lower than those seen in uncompromised patients, particularly among individuals undergoing incomplete sleeve resection [11].

**Selection of Patients for Possible Sleeve Resection**

The initial finding that identifies a possible candidate for sleeve resection is the bronchoscopic appearance of the tumor, which may extend to the lobar orifice or toward the mucosa of the adjacent main bronchus. Bronchoscopy is also helpful to delineate the nature, site, and extent of the tumor and adequately plan the resection. In some cases, CT scanning, MR imaging [12], or pulmonary angiography may be useful to determine the technical feasibility of a sleeve resection, especially for patients who cannot tolerate a pneumonectomy.

Regardless of the interpretation of mediastinal nodes by CT scan, mediastinoscopy with random node sampling should be done in every patient in whom sleeve resection is contemplated because the presence of N2 disease may indicate the need for pneumonectomy rather than sleeve resection. In our series, mediastinoscopy was done in 120 patients, and of those, only six individuals had a bronchoplasty when nodal metastases had been identified preoperatively.

The final decision to carry out a sleeve resection is generally based on operative findings such as evidence of disease along the resection line of the lobectomy, extraluminal extension of the carcinoma, and presence of N1 disease. Ultimately, the feasibility of sleeve resection can only be determined by full examination of the involved bronchi, hilum, and pulmonary artery; frozen-section biopsies of lobar, hilar, and mediastinal nodes; and frozen-section biopsies of both resection margins.

**Preoperative Radiation Therapy**

Paulson and colleagues [13] were the first to suggest that preoperative irradiation could be beneficial to obtain better localization of the tumor and sterilization of the lymphatics both to prevent local recurrences and improve survival. In their series of sleeve resections done for lung cancer, only one patient out of 20 developed a local recurrence after receiving preoperative irradiation.

In 1986, Jensik et al. [14] suggested that preoperative irradiation may be of some value to increase the chances of accomplishing a sleeve procedure, mostly for patients with limited pulmonary or cardiac reserve who could not possibly tolerate pneumonectomy. Sartori and associates [15] also demonstrated that preoperative radiotherapy neither increases complications nor has a negative effect on outcome. They, in fact, showed that radiotherapy contributes toward reducing local recurrences and maximizing tissue salvage. To date, however, there are no data that clearly demonstrate that preoperative irradiation has any effect on late survival after sleeve resection.

**Types of Sleeve Procedures**

This series comprises 142 consecutive patients who underwent sleeve lobectomy (N = 140) or sleeve resection of a main bronchus (N = 2) for bronchogenic carcinoma during a 20-year interval. There were 123 men (87%) and 19 women (13%) with a mean age of 60.7 ± 9.1 years (range, 11-78 years).

**Procedures Performed**

The majority of operations were done on the right lung (73%) (Fig. 1); an upper lobectomy with sleeve resection of the main bronchus was performed in 93 of 142 patients. The middle lobe had to be removed in continuity with the upper lobe in nine additional cases and there were two instances of lower- and middle-lobe sleeve procedures with anastomosis of the right upper lobe to the main bronchial stump.

Sleeve lobectomy of the left upper lobe was done in 17 patients and five individuals had a left lower lobectomy, sleeve resection of the main bronchus, and end-to-end anastomosis.