Postoperative complications after bronchoplastic procedures in the treatment of bronchial malignancies

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Abstract

Objective: The purpose of this study was to determine the frequency of postoperative complications after bronchoplastic procedures in the treatment of pulmonary malignant tumors and to analyze the factors influencing the complication rate.

Methods: During a 5-year-period (1992–1996) 79 patients (68 male, 11 female, mean age 57 years) underwent reconstructive operations for bronchial malignancies. We performed 58 bronchoplastic procedures and 21 combined broncho- and angioplastic procedures. Among the bronchoplastic procedures the number of sleeve resections (n = 44) and wedge resections (n = 35) were comparable.

Results: Fifty-nine patients (74.7%) showed a regular postoperative course; 12 patients (15.2%) had severe postoperative complications (death, re-operation). Concerning the primary operation the operative 30-day mortality was 5.1% (n = 4) and including the two deaths after re-operation it was 7.6% (n = 6). After subdividing the patients into three groups (severe, less severe and no complications) we tried to determine predictors for occurrence of postoperative complications. There was a higher rate of severe complications in the age group 61–70 years (6/25 = 24%) as compared with younger patients between 51 and 60 years (4/38 = 10.5%; P < 0.05). Concerning the location, the outcome was better after sleeve- or wedge lobectomies of the upper lobes (four complications/51 patients = 7.8%) compared with procedures of the lower lobes (3/14 = 21.4%). The data could not prove a lower frequency of severe postoperative complications or specific morbidity after pleural coverage following bronchial sleeve resection. The complication rate was higher when sleeve resection of the bronchus was performed (10/44 = 22.7%) as compared with wedge resections (2/35 = 5.7%; P = 0.011) and after resection of T3/T4 tumors (6/28 = 21.4%) compared with T1/T2 tumors (4/37 = 10.8%; P < 0.05).

Conclusions: Bronchoplastic procedures represent a fairly safe therapy opportunity in patients with centrally localized bronchial carcinoma and compromised or uncompromized pulmonary function. In this study the complication rate was higher after sleeve resection of the bronchus as compared with wedge resection. Pleural coverage of the anastomosis was not effective to prevent major complications due to dehiscence of the bronchial anastomosis. A pedicled muscle flap could be a valuable alternative. © 1998 Elsevier Science B.V. All rights reserved

Keywords: NSCLC; Bronchoplastic resections; Sleeve-lobectomy; Bronchoplasty; Anastomotic coverage; Complications

I. Introduction

Bronchoplastic procedures became an important element within the methodological spectrum of thoracic surgeons since the method was inaugurated by Price Thomas in a case of bronchial adenoma in 1947 [10]. In 1952 the first bronchial sleeve resection for bronchogenic carcinoma was performed by Allison [1].

In case the tumor growth spreads to the main bronchus, the resection of a sleeve-shaped part of the main bronchus in continuity with the involved lobe ("sleeve-lobectomy") represents an alternative to pneumonectomy. Bronchoplastic operations, if necessary in combination with angioplasty, are absolutely indicated in patients with compromised pulmonary function, who would not tolerate a pneumonectomy as an adequate procedure for centrally located tumors. The indication for reconstructive operations especially the combination of broncho- and angioplastic procedures as an elec-
tive operation in patients without increased risk for lung resection is still under debate. However, an increasing number of authors recommends bronchoplastic procedures in selected patients without increased risk for surgery [17,20,14]. Sleeve lobectomies in patients with lung metastases of extrapulmonary tumors have been published [3]. The advantages of these procedures are the preservation of lung parenchyma and the lower rate of postoperative complications compared with pneumonectomy. However, the complication rate after reconstructive procedures is higher than after standard lobectomies due to problems with the bronchial anastomosis [6,4].

The purpose of this study was to evaluate the rate of postoperative complications after bronchoplastic procedures under consideration of

age and gender;
operative method of bronchoplastic reconstruction (sleeve resection versus wedge resection);
side of the resection and extent of the tumour;
lymph node involvement and evidence of tumor cells at the resection margin;
histology of the lesion (squamous cell carcinoma versus other malignancies); and
methods of covering the bronchial anastomosis.

2. Patients and methods

From January 1 1992, to December 31 1996, more than 1500 operations were performed for patients with pulmonary malignant tumors. Seventy-nine patients who underwent bronchoplastic procedures over the same 5-year-period were included in this study. The mean age was 57 years and the male to female ratio 6:1. With 70% squamous cell carcinoma was the most frequent histologic diagnosis (Table 1).

A total of 58 bronchoplastic procedures and 21 combined broncho- and angioplastic procedures were performed (Table 2). Among the bronchoplastic procedures the number of sleeve resections (n = 44) and wedge resections (n = 35) were comparable.

The patients were retrospectively divided into three groups (Table 3).

Group I: patients with severe postoperative complications (death, re-operation, severe bleeding).
Group II: patients with less severe postoperative complications (pleural empyema, complicated pneumonia, secondary wound healing and Ductus thoracicus fistula).
Group III: patients with regular postoperative course.

To determine differences between subsequent groups, cross-table analysis was performed using the Chi-square-test.

During the last years an increasing number of patients with central carcinomas and advanced tumor stage was admitted to our hospital. Bronchoplastic procedures were absolutely indicated in 28 patients. This refers to patients with compromised pulmonary performance, inadequate for pneumonectomy. Under consideration of patient’s general condition a forced expiratory volume (FEV 1) lower than 1.5 l/s is used as an index. Furthermore in cases where pneumonectomy is contraindicated due to elevated pulmonary artery pressures, advanced ischemic heart disease or similar conditions, bronchoplastic procedures are considered absolutely indicated.

However, the indications for bronchoplastic procedures were elective in the majority of patients (n = 51) we operated on. If the anatomical localization of the central tumor is suitable for broncho- and/or angioplastic procedures, particularly if there was evidence for N2-status, we tried to prevent a pneumonectomy. Bronchoplastic procedures offer the same opportunity for potential cure as pneumonectomy, since it can be assumed, that the longtime survival of patients with extended central tumors is determined by distant metastases. Whenever possible a local radical resection is performed. As a result of preserving pulmonary parenchyma by performing bronchoplastic procedures patients experience a better postoperative outcome and less impairment of the pulmonary function.

The preoperative assessment of patients considered for reconstructive operations did not differ from the standard evaluation of patients with lung cancer. All patients had

<table>
<thead>
<tr>
<th>Histology</th>
<th>No. of patients</th>
<th>%</th>
<th>Complications group I</th>
<th>Complications group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squamous cell carcinoma</td>
<td>55</td>
<td>69.6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Large cell carcinoma</td>
<td>2</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenocarcinoma (including carcinoma of the mucous glands)</td>
<td>8 (3)</td>
<td>10.1 (3.8)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Small cell carcinoma</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcinoïd</td>
<td>6</td>
<td>6.6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pulmonary metastasis of extrapulmonary tumors</td>
<td>6</td>
<td>7.6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Carcinoma of the thymus gland</td>
<td>1</td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Table 1

Histologic diagnosis and major postoperative complications of 79 patients with broncho- and angioplastic tumor resection.
chest roentgenogram, CT scan of the thorax, bronchoscopy, pulmonary function tests and CT scan or sonogram of the abdomen. Pre-operative antibioprophylaxis was given to all patients with bronchial wedge or sleeve resections. Usually a cephalosporin was administered about one hour before the operation. In cases with retention pneumonia antibiotic treatment was chosen corresponding with the antibiostatic sensitivity test.

The bronchial anastomosis was carried out using interrupted absorbable sutures (Dexon 3/0 or 4/0). Vascular anastomosis was performed with continuous non-absorbable suture (Prolene 5/0, Tevdec).

A local radical resection was achieved in 81.5% (53/65 with non-small-cell primary lung carcinoma). In three patients gross residual tumor was present. Microscopic tumor invasion of definitive bronchial resection margins was seen in six patients, whereas in three patients the operation was not considered radical due to extended lymphnode involvement alone, without gross residual tumor. In case, the intraoperative situation presented any functional and technical alternatives to the surgeon, intraoperative frozen section examination of both bronchial margins, if necessary with subsequent extended resection, was obtained in all patients. Regarding lymphadenectomy, we performed a radical lymphadenectomy in almost all patients. Only in cases with lymphnode metastases invading the recurrent nerve, preservation of the nerve can be considered. An adjuvant radiotherapy is mandatory in these patients.

Concerning the primary operation the 30-day mortality was 5.1% (n = 4) and including the two deaths following re-operation it was 7.6% (n = 6). No intraoperative deaths occurred. The causes of death were:

- massive erosion bleeding from the pulmonary artery on the 5th and 18th postoperative day (n = 2);
- cardiopulmonary failure following completion pneumonectomy on the 8th postoperative day (n = 1);
- asphyxia due to dehiscence of the bronchial anastomosis and bronchovascular fistula on the 15th postoperative day (n = 1).

Two patients died of general complications (myocardial infarction after re-operation on the 10th postoperative day and gastrointestinal bleeding on the 21st postoperative day). One patient died due to erosion bleeding on the 38th postoperative day, accounting for an overall-mortality of 8.9%.

### Table 2

<table>
<thead>
<tr>
<th>Resection of lung parenchyma</th>
<th>Broncho-plasties</th>
<th>With angioplasty</th>
<th>Bronchial sleeves</th>
<th>With angioplasty</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No lung resection</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Segmental resection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right lung</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper lobectomy</td>
<td>11</td>
<td>13</td>
<td>5</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Middle lobectomy</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Lower lobectomy</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Upper/middle bilobectomy</td>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Middle/lower bilobectomy</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Left lung</td>
<td></td>
<td>3</td>
<td>3</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Upper lobectomy</td>
<td>9</td>
<td>2</td>
<td></td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Lower lobectomy</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>31</td>
<td>4</td>
<td>27</td>
<td>17</td>
<td>79</td>
</tr>
</tbody>
</table>

### Table 3

Subgroups of patients according to the postoperative course

<table>
<thead>
<tr>
<th>Postoperative course</th>
<th>No. of complications</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I: severe postoperative complications (death, re-operation)</td>
<td>12</td>
<td>15.2</td>
</tr>
<tr>
<td>Group II: surgery associated complications, which could be controlled by conservative measures</td>
<td>8</td>
<td>10.1</td>
</tr>
<tr>
<td>Group III: patients with regular postoperative course</td>
<td>59</td>
<td>74.7</td>
</tr>
</tbody>
</table>

3. Results

Fifty-nine patients (74.7%) showed a regular postoperative course. Twelve patients had severe postoperative complications (15.2%; group I) and 8 patients (10.1%; group II) had surgery associated complications which could be controlled by conservative measures (Table 2).

Concerning the primary operation the 30-day mortality was 5.1% (n = 4) and including the two deaths following re-operation it was 7.6% (n = 6). No intraoperative deaths occurred. The causes of death were:

- massive erosion bleeding from the pulmonary artery on the 5th and 18th postoperative day (n = 2);
- cardiopulmonary failure following completion pneumonectomy on the 8th postoperative day (n = 1);
- asphyxia due to dehiscence of the bronchial anastomosis and bronchovascular fistula on the 15th postoperative day (n = 1).

Two patients died of general complications (myocardial infarction after re-operation on the 10th postoperative day and gastrointestinal bleeding on the 21st postoperative day). One patient died due to erosion bleeding on the 38th postoperative day, accounting for an overall-mortality of 8.9%.
Re-operations were necessary in seven patients. Among these procedures three completion pneumonectomies were performed. The indications for re-operations were:

- Dehiscence of the bronchial anastomosis (n = 2);
- Stenosis of the bronchial anastomosis (n = 1);
- Thrombotic occlusion of the pulmonary artery proved by angiography (n = 1);
- Arrosion bleeding from the pulmonary artery (n = 1);
- Postoperative bleeding independent from the reconstructive procedure (n = 1);
- Sepsis following pneumonia in the remaining lobe after sleeve-bilobectomy (n = 1).

Two patients died after re-operation (sepsis following pneumonia; myocardial infarction). The other five patients showed a regular postoperative course.

Concerning severe postoperative complications there was no difference between male (10/68 = 14.7%) and female (2/11 = 18.2%) patients. The four cases of postoperative empyemas occurred in male patients. There was a higher rate of severe postoperative complications in the age group 61–70 years (6/25 = 24.0%) compared with younger patients between 51 and 60 years (4/38 = 10.5%; P < 0.001). Nevertheless the four patients aged 71 years and more showed a regular postoperative course (Fig. 1).

Concerning the extent of the tumor, in patients with non-small-cell primary cancer of the lung (n = 65) there was a higher rate of postoperative complications after resection of T3 (5/20) and T4 (1/8) tumors (21.4% = 6/28) as compared with T1 (1/8) and T2 (3/29) tumors (10.8% = 4/37; P < 0.05). Regarding the N factor, in cases with squamous cell carcinoma, advanced lymph node involvement was associated with a higher rate of major complications: pN0 11.1% (3/27), pN1 11.1% (1/9), pN2 17.6% (3/17), and pN3 50% (1/2). Depending on the histologic type of the tumors, patients with adenocarcinoma showed a higher rate of major complications (2/8 = 25%) than patients with squamous cell carcinoma (8/55 = 14.5%). Naturally, the relatively small sample size of patients in the group with adenocarcinoma does not allow any statistically relevant statement.

In cases without gross or microscopic evidence of residual tumour we noticed a better postoperative outcome. The rate of severe complications was 13.2% (7/53) for R0-resection, 25% (3/12) for R1 or R2-resection. The three patients with R2-resection had an uneventful postoperative course.

We observed a significantly higher rate of severe postoperative complications following sleeve resection (10/44 = 22.7%) of the bronchus compared with wedge resection (2/35 = 5.7%; P = 0.011) (Table 4, Fig. 2). The outcome was better after sleeve- or wedge lobectomies of the upper lobes (4/51 = 7.8%) compared with sleeve- or wedge lobectomies of the lower lobes (3/14 = 21.4%). However, there was no difference concerning severe complications between resections of the right upper lobe (2/29) and the left upper lobe (2/22; P = n.s.).

Regarding patients with bronchial sleeve resections, there was no correlation between pleural coverage of the bronchial anastomosis and the frequency of severe postoperative complications or specific morbidity (Fig. 3). In three recent cases intercostal muscle flap was used for anastomotic covering. No postoperative complications associated with the bronchial anastomosis were observed in these patients.

Eleven patients had complications related to the bronchoplastic procedure, which accounts for a specific morbidity of 13.9% (Table 5). All these patients are included in the above mentioned groups I/II. Among these patients four patients

![Fig. 1. The correlation between patient’s age and the rate of postoperative complications.](https://academic.oup.com/ejcts/article-abstract/14/1/46/382666)

<table>
<thead>
<tr>
<th>Bronchoplastic procedure</th>
<th>No. of patients</th>
<th>%</th>
<th>No. of severe postoperative complications</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumor resection with bronchial wedge resection</td>
<td>35</td>
<td>38.9</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>Without arterial reconstruction</td>
<td>31</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>With tangential resection of the pulmonary artery</td>
<td>4</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Tumor resection with bronchial sleeve resection</td>
<td>44</td>
<td>48.9</td>
<td>10</td>
<td>22.7</td>
</tr>
<tr>
<td>Without arterial reconstruction</td>
<td>27</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With tangential resection of the pulmonary artery</td>
<td>10</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With double sleeve resection</td>
<td>7</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>12</td>
<td></td>
<td>15.2</td>
</tr>
</tbody>
</table>
underwent re-operation and four patients died following the primary operation. Bronchopleural fistula oc-curred in three patients and in another four patients with regular postoperative course a bronchopleural fistula was suspected, but could not be proven by bronchoscopy.

In all but one patient with fatal complications related to the bronchoplastic procedure the operation with parenchymal preservation was absolutely indicated.

Among the eight patients suffering from postoperative pneumonia there were three patients, who had subsequent complications (hemorrhage due to bronchovascular fistula, pleural empyema and sepsis following pneumonia in the remaining single lobe after bilobectomy). The other five patients showed an uncomplicated course. In three of the eight patients with postoperative pneumonia the histologic examination showed distinct poststenotic pneumatic changes. In cases with sleeve resection of the bronchus, the frequency of postoperative pneumonia was higher (6/44 = 13.6%) compared with wedge resection (2/35 = 5.7%).

4. Discussion

Among the therapeutic modalities for localized non-small-cell lung carcinoma surgery is the treatment of choice for the presence. Therefore it is necessary to check the indication for surgical treatment in each single patient. The bronchoplastic procedures in combination with the resection of the involved lung parenchyma represent an alternative to pneumonectomy in patients with centrally localized carcinoma, who would not tolerate pneumonectomy due to impaired pulmonary function.

Bronchoplastic procedures are preferred to pneumonectomy by a considerable number of authors even in selected patients with normal pulmonary function, since some studies showed fewer complications and a similar outcome of patients after bronchoplastic operations, as compared with pneumonectomy [16,17,20]. According to Suri et al. [13] preoperative pulmonary arteriography could be helpful to receive valid information concerning the degree of involvement of the pulmonary artery. Thus the method could support the selection of patients for reconstructive procedures. The higher rate of postoperative mortality and complications after reconstructive procedures compared with standard lobectomies is caused by leakage of the bronchial anastomosis in the majority of cases [6]. In the literature the postoperative mortality rate varies between 1.8 and 11.4% [2,7,14,17,19]. The mortality and morbidity rate following bronchoplastic operations is lower than following pneumonectomy [16]. Yoshino et al. saw fewer postoperative complications and local recurrences after bronchoplastic procedures as compared with pneumonectomy and reported the same data concerning long time survival [20].

Voigt-Moykopf et al. noticed a higher complication rate after wedge resection of the bronchi compared with sleeve resection [18]. In consequence, they abandoned wedge resection in favour of sleeve resection.

In contrast, we found a significantly higher rate of major complications and pneumonia’s after sleeve resection of the bronchi. In case that tumor growth and sufficient margin of safety (proved by rapid section) allow wedge resection, this Table 5

<table>
<thead>
<tr>
<th>Complication related to the bronchoplastic procedure</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronchovascular fistula</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>Bleeding from arterial erosion</td>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>Dehiscence of the bronchial anastomosis</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Stenosis of the bronchial anastomosis</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>Bronchopleural fistula</td>
<td>3</td>
<td>3.8</td>
</tr>
<tr>
<td>With normal postoperative course</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>With subsequent pleural empyema</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>13.9</td>
</tr>
</tbody>
</table>

Fig. 2. The frequency of severe postoperative complications (group I) and less severe complications managed by conservative measures (group II) in correlation with the broncho- and angioplastic procedures.

Fig. 3. The frequency of severe postoperative complications and specific morbidity in correlation with the coverage of the bronchial anastomosis.
could be the procedure with the better postoperative outcome as compared with sleeve resection. In our study we did not notice any bronchopleural fistulas after wedge resection, indicating a better healing of the bronchial anastomosis. In cases of sleeve resection of the bronchus the innervation of the distal part is interrupted. This could be one explanation for an increased incidence of retained secretions and the higher rate of pneumonia’s. Inflammatory stenosis at the site of the bronchial anastomosis may be another important factor in this context. The healing of the anastomosis is closely related to a sufficient blood supply of the bronchial mucosa [5]. Nazari et al. [9] assume a correlation between a better systemic blood supply of the distal parts of the bronchus after bronchial wedge resection and the better postoperative outcome compared with sleeve resection. Comparing both methods of bronchial reconstruction it has to be considered, that in patients who underwent sleeve lobectomy an advanced tumor extension and lymph node involvement occurs more frequently. Rea et al. [11] could not confirm a higher rate of stenosis after bronchial wedge resection, described by other groups. The operative mortality rate was lower after bronchial wedge resection (bronchoplasty) compared with sleeve resection in this series. It will be the objective of a subsequent study to prove the favourable results after wedge resections during a long term follow-up. Müller et al. [8] saw even a lower rate of local recurrences after bronchial wedge resection compared with sleeve resection.

Wrapping of the anastomosis is considered by the majority of authors to reduce the incidence of severe complications caused by bronchopleural fistulas at the anastomotic site [15]. Particularly in patients with bronchial sleeve resection, we could not demonstrate a correlation between pleural coverage of the anastomosis and the rate of major postoperative complications or specific morbidity. In the literature major complications are described despite coverage with pleura and omentum [6,8]. Alternatively the authors recommend pericardial coverage. Other groups favour a pedicled intercostal flap for the coverage of the anastomosis [11,12]. In three recent cases we used intercostal muscle tissue for the anastomotic wrapping. There were no major complications associated with the bronchial anastomosis. In our opinion anastomotic wrapping is especially necessary in cases with double sleeve resection. The vital tissue could prevent spread of micro abscesses from the bronchial to the arterial anastomosis.

The complication rate was higher after resection of T3/T4 tumors compared with T1/T2 tumors and in patients with R1-resection.

Concerning the postoperative management an intensive critical care and observation of the patients is necessary in order to record postoperative complications at an early stage. Bronchosopic examination and an intensive breathing exercise should be carried out routinely. The radiological follow-up allows early detection of complications associated with the arterial anastomosis.

The results of re-operations lead to the conclusion that in cases of major complications the indication for the re-operation should be considered in early stages. With this strategy the complications can be managed in most cases.

In conclusion, bronchoplastic procedures represent a fairly safe therapy opportunity in patients with centrally localized bronchial carcinoma and compromised or uncompromised pulmonary function. In this study the complication rate was higher after sleeve resection of the bronchus compared with wedge resection. Pleural coverage of the anastomosis is not a safe method to prevent major complication due to dehiscence of the bronchial anastomosis. A muscle flap (intercostal or latissimus dorsi) could be a valuable alternative.

References

Dr Krueger: I am not sure if I understand your question. It deals with the left upper lobe sleeve lobectomy?

Dr Al-Qudah: Left pneumonectomy.

Dr Krueger: I am sorry, I cannot give you any answer to this.

Dr Al-Qudah: My question is very simple. For the left side bronchial malignancy sometimes we have to excise the tumor completely and we cannot re-establish the continuity in the retroaortic course of the bronchus, so we have to bring the left bronchus in the proaortic and we have to do the anastomosis at this site, which is more difficult and technically demanding.

Dr Krueger: In most cases of the left upper lobe bronchial reconstruction we made a double sleeve resection, yes, which was normal.

Dr Al-Qudah: And for the main stem bronchus, the left main stem bronchus?

Dr Lacquet: There was no case in this series. You mean the sleeve pneumonectomy on the left with the proaortic bronchial anastomosis?

Dr Al-Qudah: Yes.

Dr Lacquet: It was not described in this series.

Dr A.R. Brutel (Nieuwegein, The Netherlands): As this paper deals mainly with technical aspects of sleeve lobectomy, I will limit myself to some technical questions of the procedure. Already some details have been alluded to by Dr. Klepetko on nodal status of the patient, so I will not go into that. I just would like to know whether you have any experience with running suture material for the anastomosis, as is done in lung transplantation, or whether you only use interrupted sutures. I assume that all cases were done with reabsorbable material. Secondly, I would like to know whether at any operation fibrin glue was used to cover the anastomotic site. And finally, I would like to know whether you have any special release techniques to diminish tension on the anastomosis. As you will know, this can increase the risk of complications, and I wonder whether release techniques as described, for instance, by Pearson have been used in these operations.

Dr Krueger: Yes, we used only reabsorbable material and we used the interrupted suture. And concerning your second question, the fibrin glue, was used for covering the anastomosis only in some patients without encouraging results. It seems to be useful for the anastomotic wrapping in combination with vital tissue like pleura.

Dr Lacquet: Perhaps I can ask you, how do you explain that you have less complications after wedge resection than after sleeve resection, because after wedge resection very often you have a kinking of the bronchus and subsequently a stenosis. How do you explain this difference in early and late complications in this series? Is it according to a special technique? What do you think?

Dr Krueger: There are some authors reporting similar results like, for instance, Dr. Rea in 1997. One explanation for the different results could be the length of the wedge. To our knowledge a long wedge onto the other side of the bronchus (leaving only a small bridge of bronchial tissue) is more difficult and technically demanding. Dr Krueger: I am sorry, I cannot give you any answer to this.

Dr A.S. Al-Qudah (Amman, Jordan): I would like to ask if you had performed a left-sided bronchoplastic procedure with proaortic bronchial anastomosis. As you know, for the left bronchus sometimes we are obliged to excise more than planned from the bronchus, and it is very difficult to re-establish the anastomosis in the retroaortic area and we have to do the anastomosis in the proaortic area. Did you have this proaortic sleeve pneumonectomy in your series?
Dr A. Akopov (St. Petersburg, Russia): We have experience in the use of great omentum flapping coverage of the bronchial and tracheal anastomoses. We got good results. Did you use great omentum?

Dr Krueger: We did not use omentum. In the literature omentum is also recommended for the anastomotic wrapping. In contrast, there are studies, for example the study of Maggi in 1994, where omentum was used without preventing a bronchopleural fistula resulting in severe complications.