Pneumonectomy for complex aspergilloma: is it still dangerous?∗

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Abstract

Objective: Pneumonectomy for complex aspergilloma is associated with high morbidity rates. This study aimed to improve the outcomes of this high-risk procedure by preventing postoperative complications.

Methods: Between April 1999 and December 2004, 25 patients underwent pulmonary resection for complex aspergilloma at our institution. Of these patients, 11 (44%) patients (9 males and 2 females) undergoing a pneumonectomy were reviewed in this study. Median age was 63 years (range, 36—71 years). Associated pulmonary diseases were cavities secondary to tuberculosis (n = 6) and a post-lobectomy destroyed lung (n = 5). All patients presented with symptoms, including hemoptysis (n = 10) and purulent sputum (n = 1). To minimize the risk of empyema and bronchopleural fistula, careful extrapleural dissection and bronchial stump reinforcement with a latissimus dorsi muscle flap were employed in all patients. Follow-up was completed on March 31, 2005. Results: We performed six pneumonectomies (two right and four left) and five completion pneumonectomies (one right and four left). Operating time ranged from 361 to 781 min (median, 432 min). The median intraoperative blood loss was 1050 ml (range, 200—2910 ml). There was no operative mortality. No patient required re-exploration for postoperative hemorrhage. The major complications were empyema caused by anaerobic bacteria (n = 1) and chylothorax (n = 1). The treatment of both complications was successful. All patients were free from aspergillosis at the time of follow-up. Conclusions: Pneumonectomy for symptomatic complex aspergilloma can be performed with no mortality and low morbidity. The favorable results of this potentially deleterious procedure hinge on the efforts to prevent postoperative complications.

Keywords: Aspergilloma; Muscle flap; Pneumonectomy; Postoperative complications

1. Introduction

Aspergilloma (fungus ball) is one of the clinical forms of pulmonary disease due to Aspergillus and develops in patients with pre-existing cavities commonly resulting from tuberculosis [1]. Because pulmonary aspergilloma may cause life-threatening hemoptysis, the disease has been brought to the attention of chest physicians and thoracic surgeons. However, the optimal treatment strategy for aspergilloma is unknown [2]. Definitive treatment for aspergilloma is surgical resection of the affected lung [3]. Patients with the so-called simple aspergilloma are offered surgical treatment liberally because operation carries low risk. However, surgical resection for complex aspergilloma carries significant morbidity and mortality rates [4—6] which must be weighed against the clinical benefits. In particular, notably high morbidity rates have been reported when patients with complex aspergilloma undergo a pneumonectomy [7,8]. Several authors have raised admonitions against the pneumonectomy procedure [8]. The results of pneumonectomy performed on a limited number of patients with complex aspergilloma have been reported [9,10]. This report reviews our recent experience in using pneumonectomy to treat patients with complex aspergilloma with emphasis on the potential improvement in the outcome of this high-risk procedure.

2. Materials and methods

Between April 1999 and December 2004, 25 patients underwent a pulmonary resection for aspergilloma at Fukujuji Hospital in Tokyo. The resections included pneumonectomy in 11 patients (44%) and lobectomy in 14 patients (56%). The 11 patients undergoing pneumonectomy were the subjects of this study. Patients were nine males (82%) and two females (18%). Median age at the time of surgery was 63 years (range, 36—71 years). None of the patients were immunocompromised. All patients presented with symptoms, including hemoptysis in 10 patients and purulent sputum in one patient. The diagnosis of aspergilloma was confirmed by
a chest roentgenogram and/or by a computed tomographic scan of the chest in all patients. In accordance with the classification proposed by Belcher and Plummer [4], aspergilloma in all 11 patients was classified as complex. Aspergilloma had developed in cavities secondary to tuberculosis in six patients. In the remaining five patients, aspergilloma had developed in cavities corresponding to the remaining ipsilateral lung after lobectomy: three lobectomies, one bilobectomy for pulmonary neoplasm, and one lobectomy for tuberculosis (Table 1).

Preoperative studies included chest roentgenograms, computed tomographic scans of the chest, pulmonary function tests, arterial blood gas analysis, and quantitative perfusion scans. Sputum cultures for fungus and/or serologic tests for *Aspergillus* were examined on admission. Sputum cultures and serodiagnosis were positive in two patients and in seven patients, respectively. The indications for pulmonary resection were recurrent hemoptysis in 10 patients and refractory pulmonary infection in one patient. Four patients with hemoptysis underwent bronchial artery embolization, which failed. Pneumonectomy was chosen based upon the location of the aspergilloma and the extent of the underlying disease as well as upon the patient’s pulmonary reserve.

The surgery was performed under general anesthesia with the use of a double-lumen endobronchial tube. The chest was opened via a posterolateral thoracotomy and the fifth or sixth rib was removed. Pneumonectomy was performed either extrapleurally or intrapleurally, depending on the degree of pleural adhesions. For extrapleural dissection, we used electrocautery and/or bipolar scissors (PowerStar Bipolar Scissors, Ethicon Inc., Somerville, NJ, USA) to reduce blood loss [11]. In six patients, a supplementary incision via the seventh or eighth intercostal space was performed to facilitate the mobilization of the lower lobe and the diaphragmatic surface of the lung. Great care was taken to avoid entry into the infected cavities. The bronchus was divided and closed with staples in 10 patients, except in a patient for whom sutured bronchial closure was used. The bronchial stump was covered with a latissimus dorsi muscle flap in all patients. The latissimus dorsi muscle flap was constructed as described by Pairolero et al. [12]. In patients who had undergone a posterolateral thoracotomy, the proximal portion of the latissimus dorsi that had been divided during a previous thoracotomy was used as a flap. Meticulous hemostasis was again achieved using electrocautery and an argon beam coagulator. The pleural cavity was irrigated with at least 10 L of saline and povidone iodine, and then the chest was drained. All patients were extubated before leaving the operating room.

Follow-up data were obtained from outpatient or hospital charts, or by direct contact with patients or relatives. Postsurgical follow-up was completed on March 31, 2005. The duration of follow-up ranged from 0.4 to 5.8 years (median, 1.9 years). Operative mortality included all deaths clearly related to the operation, regardless of the postoperative interval. Because complications such as bronchopleural fistula and empyema might have the potential to occur as late as 1 month after surgery, all complications occurring during the surgical follow-up period were considered postoperative complications.

### 3. Results

Preoperative pulmonary function tests showed that vital capacity ranged between 1.07 and 3.23 L (median, 2.59 L) and forced expiratory volume in 1 s ranged between 0.64 and 2.57 L (median, 1.66 L). Perfusion scans revealed that 2.9–38.5% (median, 5.6%) of perfusion was to the operated lung (Table 1).

We performed six pneumonectomies (two right and four left) and five completion pneumonectomies (one right and four left). Operations were elective in all patients. A patient having had aspergilloma in the post-tuberculous cavity underwent a cavernostomy at first because of his poor respiratory function (forced expiratory volume of 0.87 L in 1 s). As he continued to present with hemoptysis, we chose to perform pneumonectomy 2 months later. Operating time ranged between 361 and 781 min (median, 432 min). The median intraoperative blood loss was 1050 ml (range, 200–2910 ml) (Table 2). Intrapulmonary dissection was required in two patients undergoing a completion pneumonectomy. One vascular tear occurred (right pulmonary artery), but was easily controlled. The diaphragm was severed in three patients; all tears were recognized and repaired intraoperatively. The chest wall with three ribs adjacent to the obliterated pleural space was resected concomitantly in two patients in whom the pleural adhesion was very intense for extrapleural dissection. Tailored thoracoplasty was performed as a supplementary procedure in two other patients.

### Table 1

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Age (year)</th>
<th>Sex</th>
<th>Underlying disease</th>
<th>VC (L)</th>
<th>FEV1 (L)</th>
<th>Blood flow to removed lung (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>M</td>
<td>TB</td>
<td>3.04</td>
<td>2.18</td>
<td>38.5</td>
</tr>
<tr>
<td>2</td>
<td>57</td>
<td>M</td>
<td>TB</td>
<td>3.02</td>
<td>2.24</td>
<td>15.1</td>
</tr>
<tr>
<td>3</td>
<td>66</td>
<td>M</td>
<td>Post-LUL</td>
<td>2.20</td>
<td>1.65</td>
<td>4.1</td>
</tr>
<tr>
<td>4</td>
<td>63</td>
<td>M</td>
<td>TB</td>
<td>2.63</td>
<td>2.36</td>
<td>24.1</td>
</tr>
<tr>
<td>5</td>
<td>66</td>
<td>M</td>
<td>Post-LLL</td>
<td>2.00</td>
<td>1.61</td>
<td>4.0</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
<td>M</td>
<td>TB</td>
<td>3.08</td>
<td>2.57</td>
<td>9.3</td>
</tr>
<tr>
<td>7</td>
<td>64</td>
<td>F</td>
<td>Post-LLL for TB</td>
<td>1.91</td>
<td>1.95</td>
<td>4.8</td>
</tr>
<tr>
<td>8</td>
<td>71</td>
<td>M</td>
<td>Post-LLL</td>
<td>1.87</td>
<td>1.77</td>
<td>3.1</td>
</tr>
<tr>
<td>9</td>
<td>66</td>
<td>F</td>
<td>Post-RUML</td>
<td>1.07</td>
<td>0.64</td>
<td>2.9</td>
</tr>
<tr>
<td>10</td>
<td>54</td>
<td>M</td>
<td>TB</td>
<td>2.59</td>
<td>0.87</td>
<td>5.6</td>
</tr>
<tr>
<td>11</td>
<td>38</td>
<td>M</td>
<td>TB</td>
<td>3.23</td>
<td>1.66</td>
<td>12.0</td>
</tr>
</tbody>
</table>

F: female; FEV1: forced expiratory volume in one second; LLL: left lower lobectomy; LUL: left upper lobectomy; M: male; RUML: right upper and middle lobectomy; TB: tuberculosis; VC: vital capacity.
Despite careful dissection, a small amount of the contents of aspergillosis was split into the operative field in four patients. There was no operative mortality. No patient required reexploration for postoperative hemorrhage. Two major complications occurred in two patients, including empyema in one patient (9%) and chylothorax in one patient (9%) (Table 2). A patient with left pneumonectomy developed an empyema 4 days after the operation despite the fact that no gross contamination of the operative field occurred during dissection. The patient was returned to the operating room and underwent open window thoracostomy. The culture of the pleural lavage taken at the conclusion of pneumonectomy and the pleural fluid collected during re-operation were positive for *Bacteroides fragilis*. Chylothorax occurred in a patient undergoing a right pneumonectomy on the third postoperative day. Conservative management, including bowel rest and total parenteral nutrition, failed to decrease the daily amount of drainage. Successful control of the leakage of chyle was achieved by ligation of the thoracic duct tributaries on the eighth postoperative day. Length of hospital stay after the surgery ranged from 27 to 70 days (median, 37 days), because all patients required prolonged chest physiotherapy to recuperate.

One patient died of cachexia 6.7 months after the operation with no sign of recurrence of aspergillosis. All survivors were free from aspergillosis at the time of follow-up.

### 4. Discussion

As pulmonary aspergillosis may cause life-threatening hemoptysis, symptomatic patients with aspergillosis are deemed candidates for therapy [2]. Efficacy of medical treatment for aspergillosis is still limited, and definitive treatment is surgical removal of the affected lung [3]. Belcher and Plummer [4] divided aspergillosis into two groups: simple aspergillosis and complex aspergillosis, according to the nature and extent of the underlying disease of the lung. Simple aspergillosis develops in isolated thin-walled cysts of bronchial origin with little or no abnormality in the surrounding lung. On the other hand, complex aspergillosis develops in cavities with gross disease in the surrounding lung tissue. Patients with simple aspergillosis are considered good candidates for pulmonary resection because surgery carries little risk. However, surgical removal of complex aspergillosis is associated with a high incidence of complications following operation [4–8].

When surgical resection is performed, lobectomy is the most common procedure [4–8,13–16]. Pneumonectomy is preferred over less aggressive procedures for patients with multiple lobes affected by aspergillosis or with a totally destroyed underlying lung. However, previous studies have reported that pneumonectomy for complex aspergillosis is associated with extremely high complication rates [7–10]. During the pneumonectomy procedure for complex aspergillosis, surgeons encounter dense fibrosis with obliteration of the pleural space, extension beyond the extrapleural plane of dissection, and distortion of hilar structures [9].

These structural alterations due to the inflammatory disease process make dissection extremely difficult. Many investigators experience excessive blood loss in patients undergoing a pneumonectomy for complex aspergillosis [8,13,14]. Following the surgery, a high incidence of dreadful complications, such as empyema and bronchopleural fistula, should be anticipated. Massard et al. [8] reported that empyema developed in four of the five patients undergoing pneumonectomy. In the report by Babatasi et al. [13], two empyemas with bronchopleural fistula occurred after seven pneumonectomies. Regnard et al. [14] experienced two empyemas following 10 pneumonectomies. In the report by Kim et al. [15], post-pneumonectomy empyema occurred in two of the three patients undergoing pneumonectomy.

Therefore, prevention of intraoperative and postoperative complications is crucial to an improved outcome of this high-risk procedure. Techniques employed in pneumonectomy for mycobacterial diseases can be applied in pneumonectomy for complex aspergillosis: meticulous extrapleural dissection and bronchial stump reinforcement with the muscle flap [17,18]. Meticulous extrapleural dissection can minimize the risk of contamination of the operative field and reduces blood loss. Stump reinforcement with the muscle flap can prevent bronchial stump disruption. We have taken these preventative measures in all cases undergoing pneumonectomy for complex aspergillosis since 1999.

In all the cases of this report, extrapleural dissection was carried out using diathermy. An argon beam coagulator was used for hemostasis of the pleural wall at the conclusion of the operation. Moreover, in two patients we concomitantly resected the adjacent chest wall where it was extremely

### Table 2

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Procedure</th>
<th>Side operated</th>
<th>Operating time (min)</th>
<th>Bleeding (ml)</th>
<th>Postoperative complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P</td>
<td>Right</td>
<td>459</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>P</td>
<td>Left</td>
<td>432</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CP</td>
<td>Left</td>
<td>454</td>
<td>1440</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>P</td>
<td>Left</td>
<td>410</td>
<td>1060</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CP + CWR</td>
<td>Left</td>
<td>781</td>
<td>2910</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>P</td>
<td>Left</td>
<td>385</td>
<td>540</td>
<td>Empyema</td>
</tr>
<tr>
<td>7</td>
<td>CP</td>
<td>Left</td>
<td>396</td>
<td>370</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CP + CWR</td>
<td>Left</td>
<td>651</td>
<td>1255</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>CP + T</td>
<td>Right</td>
<td>536</td>
<td>1275</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>P + T°</td>
<td>Right</td>
<td>387</td>
<td>1050</td>
<td>Chylothorax</td>
</tr>
<tr>
<td>11</td>
<td>P</td>
<td>Left</td>
<td>361</td>
<td>900</td>
<td></td>
</tr>
</tbody>
</table>

CP: completion pneumonectomy; CWR: chest wall resection; P: pneumonectomy; T: thoracoplasty. ° Patient with preparatory cavernostomy.
difficult to perform extrapleural dissection because of dense adhesion. This technique avoids entering the infected cavities, reduces chest wall oozing, and decreases the size of the post-pneumonectomy space. Tailored thoracoplasty was performed on two other patients undergoing a right-sided operation in an attempt to decrease the size of the post-pneumonectomy space.

As previously pointed out [10,19,20], left-sided disease was predominant among patients with cavities secondary to tuberculosis (four of six) in our study. We also confirmed left-side predominance among patients with post-lobectomy destroyed lung (four of five). This phenomenon has not been previously reported. The median operating time was 432 min and the median intraoperative blood loss was 1050 ml. These figures are comparable with figures from previous studies. In the report by Reed [9], in which 8 of the 13 patients requiring a pneumonectomy had aspergilloma, the mean operating time was 5.7 ± 0.6 h and the mean estimated blood loss was 2083 ± 519 ml (range, 800—7000 ml). Massard et al. [10] demonstrated intraoperative blood loss averaging 2148 ± 1220 ml in patients with aspergilloma undergoing a pneumonectomy.

We have achieved no operative mortality. Our morbidity included empyema in one patient and chylothorax in another patient. Empyema developed in one patient in whom no pleural contamination occurred grossly, i.e., rupture of the infected cavity did not occur during dissection. In this patient, both the pleural lavage at the initial operation and the pleural fluid at the re-operation were positive for *B. fragilis*. Therefore, microscopic contamination might have occurred during the pneumonectomy procedure, resulting in empyema. Chylothorax was due to the incidental injury of the thoracic duct tributaries during extrapleural dissection. The injury was not recognized during the initial operation, and re-operation was finally required to stop the chylous leakage. Administration of cream before pneumonectomy might be recommended for patients in whom extrapleural dissection in the posterior mediastinum is anticipated.

A few limitations to this study should be pointed out. First, this was a retrospective single-arm study. The patients in this study were a highly selected group. Even though we performed pneumonectomy on patients with relatively marginal respiratory functions, we offered cavernostomy to patients who were too ill for pneumonectomy. Second, the number of patients enrolled in this study was small. Previous studies, however, included 7—10 patients [9,10,13,14]. To the best of our knowledge this study is one of the largest published series.

In conclusion, pneumonectomy for symptomatic complex aspergilloma can be performed with no mortality and low morbidity. The favorable results of this potentially deleterious procedure hinge on the efforts to prevent postoperative complications.

References


Appendix A. Conference discussion

Dr A. Turna (Istanbul, Turkey): I would like to know if you used antifungal therapy, intracavitary or systemically, in your patients.

Dr Shiraiishi: Yes, of course we did antifungal therapy before surgery, but in almost all patients antifungal therapies did not achieve good results.

Dr Turna: You did it in every patient?

Dr Shiraiishi: Every patient.

Dr Turna: And the second question, the empyema patients, were they aspergillosis empyema or nonspecific empyema patients?

Dr Shiraiishi: The empyema was caused by anaerobic bacteria, like Enterobacter, and in this patient, no gross contamination occurred during dissection, but actually the patient had empyema, so we don’t know why this patient had empyema.

Dr H. Shennib (Montreal, Canada): I have also noticed that you had 2 patients who had completion pneumonectomy, and I would assume that those patients underwent sort of a lesser resection before. I would like to get from you your strategy as to the choice of procedure, particularly that we all kind of struggle with the extent of the disease in a particular lung and how much we should we resect. So how do you sort out the patients, and when do you decide to do a limited lobectomy, for example, versus a pneumonectomy in your group.
of patients? The other question is, in those patients who had completion pneumonectomy, did you notice an increased morbidity as a result of the delay of a pneumonectomy in those patients?

Dr Shiraishi: Regarding the first question, of course we tried to leave as much lung parenchyma as possible. So at first we tried to do lobectomy, but in this series patients had a totally destroyed lung or multiple lobes affected by aspergilloma, and in that case we had to do pneumonectomy. In terms of comparison of pneumonectomy with completion pneumonectomy, actually we didn’t see any difference in complication rates between pneumonectomy patients and completion pneumonectomy patients.

Dr C. Paleru (Bucharest, Romania): I’m thinking about the average mean time of operation, 700 minutes of operation. One, do you plan in such an operation to use two teams of surgeons? Two, how can you prevent the spillage of aspergilloma in a reoperation?

Dr Shiraishi: Regarding the first question, actually we have only 4 surgeons on our staff, so usually we do this kind of operation with 2 surgeons.

I don’t understand your second question.

Dr Paleru: The second question was about how you free the lung after the first operation without spilling aspergilloma.

Dr Shiraishi: What do you mean?

Dr Paleru: When you are trying to do a reoperation after a first aspergilloma and the aspergilloma is still in the lung and you have some very dense adhesions, how can you prevent the spill of the fungus in the pleural cavity by technical means?

Dr Shiraishi: We prefer to do extrapleural dissection instead of intrapleural dissection, and we sometimes resect the chest wall together with the lung.

Dr M. Zielinski (Zakopane, Poland): I would like to ask you if you would consider any lesser procedure in high-risk patients. In our department, in very high-risk patients we prefer not to do any resection but to do a cavernoscopy or cavernomyoaplasty, which is a much lesser procedure. Do you have an opinion on those kinds of procedures?

Dr Shiraishi: Yes, I agree with you. If a patient has very poor pulmonary function, we do a cavernostomy instead of pulmonary resection.