Management of massive hemoptysis in a thoracic surgical unit

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Abstract

Objective: Massive hemoptysis is a life-threatening condition. Surgery is effective but we are sometimes reluctant to operate on patients with this condition. We reviewed our experience with patients who underwent emergency surgery for massive hemoptysis to verify the indications for non-emergency surgical intervention. Methods: We reviewed chest computed tomography (CT) and angiographic and pathological findings and the postoperative course of 25 patients who underwent emergency pulmonary resection in our department between 1979 and 2001 due to life-threatening hemoptysis. Results: CT revealed a persistent cavity within the radiological opacity before massive hemoptysis in 12 patients (48%). Of the 21 patients who underwent angiography, nine showed focal bleeding in one bronchial branch and the others showed bleeding in multiple branches. Of these nine patients, seven did not undergo embolotherapy mainly due to minor vascularity. In the remaining patients, embolotherapy was not indicated in six due to multiple bleeding feeders and recurrence after embolotherapy was seen in six. Pathological findings showed that eight of the 12 patients with multiple systemic shunts had a fungal infection. Operative morbidity and hospital mortality were 32 and 4%, respectively. There was no recurrence in patients who underwent surgical treatment. Conclusions: Early pulmonary resection is indicated in patients with hemoptysis of multiple branches from the cavity and chest wall, such as in fungal infections. When a bronchial branch is the only bleeding focus, superselective embolotherapy should be considered prior to surgery even if the localized focus of the bronchial branch shows minor vascularity on the angiography.

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1. Introduction

Massive hemoptysis is associated with a mortality rate of greater than 50% [1–3]. Several therapeutic strategies have been applied in the clinical setting with variable results [4–14]. In the late 1960s, emergency lung resection reduced mortality from 40 to 15% [5]. This approach remains widely practiced today, but overall mortality, especially after emergency surgery, is still high, ranging from 10 to 38% [4,6–9]. We reviewed our experience with patients who underwent emergency pulmonary resection for massive hemoptysis during the past 22 years to determine the indications for surgery with a view to the avoidance of emergency situations in future patients.

2. Patients and methods

Major hemoptysis was defined by one or more of the following: bleeding of 200 ml or more per 24 h, bronchial blood loss causing hemodynamic or respiratory compromise, or bleeding resulting in a hematocrit of less than 30%. Twenty-five patients underwent emergency pulmonary resection in our division between January 1979 and December 2001 due to major hemoptysis. We reviewed chest computed tomography (CT) and angiographic findings, clinical course to surgery, surgical procedures, morbidity and mortality, pathological findings and outcomes. There were many cases of massive hemoptysis due to cancer but these were not included because it is a policy to operate on these straight away.

Patients comprised 18 men and seven women with an average age of 52 years ranging from 21 to 80 years (Table 1). Eight patients were current smokers, four previous smokers and 13 non-smokers. Average white blood cell count and serum C-reactive protein concentration at the
3. Results

3.1. Chest computed tomography findings (Table 2)

The findings before massive hemoptysis available for 23 patients indicated a cavity within the radiologic opacity in 12 patients. Of these, two had extensively destroyed lung parenchyma, and one had tumor. Persistent atelectasis or atrophy of lung segments on the chest CT image was apparent in eight patients. Two patients had no abnormal findings to suggest the cause of the hemoptysis. Bleeding sites were located in the right lung of 12 patients and the left lung of 13 patients. The middle lobe was the most common site in the right lung (six patients).

3.2. Angiographic findings (Fig. 1)

Chest angiography, which was available for 21 patients, showed a hypervascularized bronchial branch in four patients and a minor vascularized bronchial branch in five patients.
and multiple branches, including the intercostal, thoracic, or phrenic branches, in 12. Of nine patients who had hemoptysis from the bronchial branch alone, seven did not undergo embolotherapy; this was due to minor vascularity in five patients, iodine shock in one and a communication between the bronchial and spinal arteries in one patient. Of 12 patients who had hemoptysis from multiple branches, embolotherapy was not indicated in six patients due to multiple systemic feeders. Eight patients underwent embolotherapy using an absorbable gelatin sponge. Four of the five patients whose bleeding recurred within 3 days after embolotherapy had multiple bleeding foci. Late bleeding occurred in three patients – at 2, 6 and 18 months in each of the three patients, respectively.

3.3. Operations, postoperative complications and hospital course (Table 3)

Either segmentectomy or lobectomy was performed in 17 patients, right middle lobectomy plus anterior segmentectomy in one, right upper and middle lobectomies in one and pneumonectomy including completion pneumonectomy in six patients. Partial pleurectomy was performed in 10 patients because of severe pleural adhesion. Peribronchial stripping was performed in all cases. Operation time ranged from 90 to 540 min (average 285 min) and that of the patients after the pleurectomy was 370 min on an average. Operative blood loss ranged from 100 to 5200 ml (average 980 ml) and that of the patients after pleurectomy was 1900 ml on an average.

Respiratory failure, diagnosed when prolonged ventilatory support was needed for more than 3 days after the operation, occurred in three patients after lobectomy. Three patients with pleural hemorrhage underwent a redo-thoracotomy. One patient had empyema after the right pneumonectomy and underwent thoracoplasty following open window thoracotomy. One patient had bronchopleural fistula after right and middle lobectomies for pulmonary aspergillosis. He underwent omentopexy following open window thoracotomy. Operative morbidity was 32% (eight of 25), and that of the patients who underwent extensive lung resection beyond lobectomy was 50% (four of eight) and for the patients after pleurectomy it was 40% (four of 10). Hospital mortality was 4% (one of 25); this patient died of respiratory failure with pneumonia 3 months after right middle lobectomy.

3.4. Pathological diagnoses

Pathological study suggested lung abscess in 13 patients, fungal abscess in 12 and bacterial abscess in one (Table 4). Organizing pneumonia with or without bronchiectasis was seen in nine patients. Miscellaneous complications included congenital hypoplastic pulmonary artery, pulmonary sequestration and intrapulmonary foreign body. Among the 12 patients in whom bleeding originated only from the bronchial branches, seven had organizing pneumonia. Eight of the 12 patients in whom bleeding originated from non-bronchial branches had a fungal infection such as pulmonary aspergillosis (Table 5).

3.5. Outcomes

One patient died of respiratory failure with pneumonia 3 months after right lower lobectomy. One patient died of cerebral infarction 9 years after the operation. There was no recurrence in the other 23 patients. The follow-up period ranged from 1 to 20 years (average 6 years).

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Fig. 1. Schema showing the management of massive hemoptysis from bleeding sites identified by angiography in our study. N, number of patients; BA, bronchial artery.

Table 3

<table>
<thead>
<tr>
<th>Pulmonary resection</th>
<th>No. of patients</th>
<th>Complications (no. of patients)</th>
<th>No. of operative deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segmentectomy</td>
<td>6</td>
<td>Pleural hemorrhage (1)</td>
<td></td>
</tr>
<tr>
<td>Lobectomy</td>
<td>11</td>
<td>Respiratory failure (3)</td>
<td>1</td>
</tr>
<tr>
<td>Bilobectomies, etc.*</td>
<td>2</td>
<td>Bronchopleural fistula (1)</td>
<td></td>
</tr>
<tr>
<td>Pneumonectomy</td>
<td>6</td>
<td>Pleural hemorrhage (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Empyema (1)</td>
<td></td>
</tr>
</tbody>
</table>

* Right middle and lower lobectomies, right middle lobectomy plus anterior segmentectomy.
Discussion

The definition of massive hemoptysis varies widely in the literature, from blood loss volumes of 200–1000 ml per day [1]. However, hemoptysis should be evaluated not in terms of the volume of bleeding but from the standpoint of its threat [15]. Massive hemoptysis causes acute or persistent airway obstruction and anemia or hypotension severe enough to require blood transfusion. Massive hemoptysis was defined as such in this study.

Common causes of massive hemoptysis are neoplasm, infections, cardiovascular diseases, collagen diseases and coagulopathies. Chronic inflammatory lung disease and bronchogenic carcinoma remain the most common causes. We reviewed the patients who underwent emergency pulmonary resection except for patients with lung neoplasm. The demography of the population sample in this study differs from that in previous reports associated with massive hemoptysis.

Massive and untreated hemoptysis is associated with a high mortality [1–3]. The emergency first aid treatment is resuscitation and supportive measures. Patients should be treated in an intensive care unit monitoring vital signs and oxygen saturation. The ideal time for bronchoscopy is controversial. The consensus is an indication of emergency bronchial therapy following bronchoscopic suction and exploration of the lungs in the patient with worsening hypoxia; whereas delayed bronchoscopy is preferred in stable patients on conservative management, especially when bleeding lesions are indicated by chest CT and angiography.

Bronchial measures and interventional angiography have become increasingly more widely accepted approaches to patient care [1,3,10–14]. Surgical resection is usually performed only after these measures fail in patients who are considered good candidates for surgery, even though surgery is a more promising strategy than conservative treatment [4]. The mortality rates after emergency lung resection is still high [6–9]. Aspiration pneumonia can compromise the pulmonary reserve, and it is difficult to limit the extent of lung resection to minimize sacrifice of functional lung tissue. Extensive lung resection is associated with a high mortality rate in reports of patients similar to ours [9]. Our study was conducted for the purpose of improving operative morbidity and mortality rates, and we conducted our study on good surgical candidates with sufficient pulmonary reserve before massive hemoptysis.

Thoms et al. recommend pulmonary resection if there is life-threatening hemoptysis in the patient with radiographic evidence of a cavity [15]. The tuberculotic cavity has a small pulmonary arterial aneurysm (Rasmussen’s aneurysm) that can rupture and cause massive hemoptysis [1], while the incidence of hemoptysis secondary to tuberculosis has decreased [16]. Most cavities in this study were associated with fungal infection, because we cannot treat legally the patients with active tuberculosis in our institute. Bleeding commonly originates from bronchial and/or extensive recruited chest wall collaterals through pleural adhesions [17]. In patients with persistent atelectasis and consolidation, chronic infection induces collapse and deterioration of lung parenchyma and constitutes the most common cause of massive hemoptysis. The alterations in the bronchial arterial system in these inflammatory processes are well documented [18,19]. In those patients with destroyed lung, including cavity and persistent consolidation, both factors may cause hemoptysis.

Table 4
Pathological findings

<table>
<thead>
<tr>
<th>Pathological findings</th>
<th>No. of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abscess</td>
<td></td>
</tr>
<tr>
<td>Fungus</td>
<td></td>
</tr>
<tr>
<td>Aspergillus</td>
<td>7</td>
</tr>
<tr>
<td>Actinomyces</td>
<td>3</td>
</tr>
<tr>
<td>Not identified</td>
<td>2</td>
</tr>
<tr>
<td>Bacteria</td>
<td>1</td>
</tr>
<tr>
<td>Organizing pneumonia</td>
<td>9</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>Foreign body</td>
<td>1</td>
</tr>
<tr>
<td>Hypoplastic pulmonary artery</td>
<td>1</td>
</tr>
<tr>
<td>Pulmonary sequestration</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5
Bleeding sites in relation to pathological findings

<table>
<thead>
<tr>
<th>Pathological findings</th>
<th>BA (n = 12)</th>
<th>Multiple (n = 12)</th>
<th>Aberrant (n = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of patients (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizing pneumonia</td>
<td>7 (58)</td>
<td>2 (17)</td>
<td>0</td>
</tr>
<tr>
<td>Fungal infection</td>
<td>4 (33)</td>
<td>8 (67)</td>
<td>0</td>
</tr>
<tr>
<td>Bacterial infection</td>
<td>1 (8)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hypoplastic PA</td>
<td>0</td>
<td>1 (8)</td>
<td>0</td>
</tr>
<tr>
<td>Foreign body</td>
<td>0</td>
<td>1 (8)</td>
<td>0</td>
</tr>
<tr>
<td>Pulmonary sequestration</td>
<td>0</td>
<td>0</td>
<td>1 (100)</td>
</tr>
</tbody>
</table>

PA, pulmonary artery; BA, bronchial artery.
Chest angiography in 21 of our patients showed a hypervascularized bronchial branch in four, a mildly vascularized bronchial branch in five and multiple non-bronchial thoracic pulmonary shunts in 12 patients. Bleeding originates from the bronchial artery in the majority of patients [1]. Embolotherapy for bronchial arteries achieves immediate control of the bleeding in 75–90% of patients [2]. Even mild bleeding originating from the bronchial artery can cause life-threatening hemoptysis due to high blood pressure [1]. Vascularity shown angiographically has no correlation with the degree of hemoptysis [11,14]. In the present study, five of nine patients with hemoptysis originating in the bronchial branch showed minor vascularity of staining or pooling; therefore, embolotherapy was not indicated. Whether or not embolization of these vessels is worthwhile is still open to debate [14]. The major risk of bronchial arterial embolotherapy is spinal cord injury. The reported prevalence of spinal cord injury is less than 1% [20], and superselective embolotherapy should be performed when the spinal artery arises from the bronchial artery, as in one of our patients [21]. However, spinal cord injury may be most prevalent in patients who have undergone previous thoracic surgery and embolotherapy, which can affect blood supply to the spinal cord [22,23].

Recurrence of hemoptysis after embolotherapy may be caused by the following: incomplete embolization, recanalization of the embolized vessels, or revascularization of collateral vessels associated with the progression of native disease [2,10]. The first may be attributed to failure of embolotherapy in collateral vessels, which can lead to early rebleeding. Four of five patients with early recurrence after embolotherapy showed bleeding localization from multiple branches. The last two factors may be associated with the embolotherapy material itself or such persistent chronic infections as fungus ball; these result in late recurrence of bleeding. Rebleeding occurred within 30 days in 10–30% of the patients who underwent adequate embolotherapy [13]. It is important to use polyvinyl chloride and coils that can provide permanent occlusion compared to an absorbable gelatin sponge and to treat the underlying disease condition after embolotherapy [2,13].

Marshall et al. reported that most bronchopneumonia originated from the bronchial branch and that 50% of aspergilloma originated from multiple arteries [11]. In our pathological findings, among 12 patients whose bleeding originated only from the bronchial branch and who underwent emergency surgery, seven had organizing pneumonia without collateral vessels through the chest wall. Embolotherapy was not indicated due to mild vascularity in five of the seven, but it might be successful in these patients. Among 12 patients who had bleeding through the chest wall from non-bronchial systemic arteries such as the phrenic, intercostal, mammary, or subclavian arteries through the chest wall, eight had fungal infection that induced pleural fibrosis with neovascularization. Successful embolotherapy has been reported for multiple feeders in patients with massive hemoptysis [23–25]. Incomplete embolization or early rebleeding may occur. When a fungal infection cannot be completely resolved, combination therapy of embolotherapy and surgery is more promising than surgery alone in good surgical candidates to avoid emergency situations and to reduce operative blood loss [10,17].

We emphasize that early pulmonary resection should be considered, even after control of hemoptysis, when the following clinical features, chest CT and angiographic findings are present: persistence of cavitary lesions and atrophic lung segments due to chronic infection such as fungal infection and bleeding from multiple feeders including the non-bronchial systemic arteries.

References


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