



ELSEVIER

European Journal of Cardio-thoracic Surgery 24 (2003) 689–693

EUROPEAN JOURNAL OF
CARDIO-THORACIC
SURGERY

www.elsevier.com/locate/ejcts

Pulmonary resection for massive hemoptysis of benign etiology

Adel Ayed*

Department of Surgery, Faculty of Medicine, Kuwait University and Chest Diseases Hospital, Safat, Kuwait

Received 27 June 2003; received in revised form 3 August 2003; accepted 9 August 2003

Abstract

Objective: To assess the outcome of pulmonary resection in the management of massive hemoptysis caused by benign lung diseases. **Methods:** A longitudinal cohort study of 53 consecutive patients who presented with hemoptysis and were treated with either emergency (group 1) or elective (group 2) pulmonary resection from January 1995 to December 1999. **Results:** Fifty-three patients were studied, 27 in group 1 and 26 in group 2. The mean age of the patients was 47.2 years (range, 29–70 years). Urgent examination with a combination of rigid and flexible fiberoptic bronchoscope localized the bleeding site in 45 patients (85%). Age > 50 years, hypertension, hemoglobin on admission < 10 g/dl, cause of hemoptysis, and a prior attack of hemoptysis were the predictors for the need of emergency surgery. The overall hospital mortality rate was 4% (2/53). Postoperative complications occurred in 13 patients (25%). Complications were more common in patients who received blood transfusion than non-transfused patients (9/23 and 4/30, respectively; $P = 0.03$). Patients with tuberculosis as the cause of massive hemoptysis had more complications 5/8 in comparison to all other patients ($P = 0.02$). The mean follow-up was 4.5 years (range, 3–6 years) for all patients who survived. Hemoptysis recurred in four patients (8%) and all from group 1 ($P = 0.02$). **Conclusions:** Immediate pulmonary resection for massive hemoptysis is effective in case of life-threatening bleeding that is not controlled by conservative measures. Elderly patients with a prior history of hemoptysis and/or hypertension and bleeding due to a fungus ball, necrotizing pneumonia, tuberculosis or lung abscess should be considered for early operation in an attempt to reduce morbidity and mortality.

© 2003 Elsevier B.V. All rights reserved.

Keywords: Hemoptysis; Bronchoscopy; Pulmonary resection; Tuberculosis

1. Introduction

Massive hemoptysis is a life-threatening condition because it can cause sudden airway or hemodynamic compromise. It is associated with a mortality rate of 25–50% in most series [1–3]. Treatment modalities reported for massive hemoptysis include conservative medical therapy, surgical therapy (pulmonary resection), endobronchial control measures (balloon tamponade, endobronchial iced saline lavage), and embolization of the bronchial vessels [4–6]. Despite adequate treatment, relapses are unpredictable. In case of a localized lesion, pulmonary resection is the optimal treatment. The objectives of this study are to determine the best time for surgical therapy, and assess the out-come of elective or emergency pulmonary resection for patients with massive hemoptysis of a benign etiology.

2. Materials and methods

We evaluated 53 consecutive patients presenting with massive hemoptysis from January 1995 to December 1999. We considered the hemoptysis massive when the expectoration of 600 ml. or more of blood over 24 h. All patients included in this study satisfied this criteria. During the study period five patients with massive hemoptysis were not included in the study. The diagnosis compromised three patients with lung cancer and two patients with bilateral bronchiectasis. Three lung cancer cases were managed conservatively, then were referred for radiation therapy due to extensive disease and associated superior vena cava syndrome. Two patients with bilateral bronchiectasis had poor lung function and were managed conservatively.

All of the patients were admitted to the Thoracic Surgery Unit and received resuscitative measures and conservative management with strict bed rest, and the patients were placed in lateral decubitus toward the bleeding site if known. A controlled humidified oxygen/air mixture was administered by mask. After insertion of large intravenous

* Tel.: +965-531-9475; fax: +965-531-9597.

E-mail address: adel@hsc.kuniv.edu.kw (A. Ayed).

cannula, a mild sedation (diazepam) was given every 6 h; cough suppressants and broad-spectrum antibiotics were given. Baseline hematology, biochemistry, and clotting tests were performed. Collected sputum was stained for bacteria, acid-fast bacilli, and fungi. A chest X-ray was subsequently done. All patients underwent a combination of a rigid and flexible fiberoptic bronchoscope to localize the bleeding and to carry out endobronchial control measures where feasible. These consisted of iced saline lavage, adrenaline–saline lavage, and isolation of the bleeding lung in some patients by the use of a double-lumen endotracheal tube. This treatment was successful in 26 patients. Of these, 23 had bronchiectasis, one had tuberculosis, one necrotizing pneumonia, and one a lung abscess. A computed tomography (CT) scan was then performed. Patients were divided into two treatment groups. Group 1 had an immediate operation close to the bleeding crisis and within 24–48 h from presentation. This was because of persistence of bleeding in spite of conservative measures. All patients had a CT scan, but only eight underwent a lung function test. A pulmonary isolation by insertion of a double-lumen endotracheal tube was necessary in seven of the 27 patients. The operation was performed after stabilizing the patient and after confirmation of a localized lesion. Group 2 had a delayed operation 4–20 days (mean 9.3 days) after acute massive hemoptysis was stopped medically. Medical treatment included bed rest, insertion of large intravenous cannula, monitoring of blood gases, sedation, and antibiotics. All patients had a pulmonary function test before undergoing surgery. Surgery was indicated on an elective basis for definitive treatment of anatomically localized lesions.

The data obtained included medical history, preoperative blood transfusion, history of previous hemoptysis, distribution of the disease, hospital outcome and prognosis. All

patients were followed up in the outpatient department at intervals of 1 month, 3 months, 6 months, and then every year. The follow-up included clinical history, physical examination, and chest radiograph for all patients. Inquiries were made regarding recurrence of hemoptysis and new pulmonary symptoms.

2.1. Statistical analysis

Data were expressed as mean, number, or percentages. Data analyses were made using SPSS software for Windows version 8 packages (SPSS, Chicago, IL, USA). The cut-off level for statistical significance was $P < 0.05$. The unpaired Student's *t*-test was used to assess the significance between means of continuous variables in two groups. The Pearson Chi-squared test was used to ascertain the significance of association between two categorical variables. The Chi-squared test was replaced by Fisher's exact test if the cell frequencies of any of the 2×2 contingency tables dropped below 5. Multivariate analysis was used to identify predictors for emergency operation.

3. Results

There were 30 men and 23 woman aged 29–70 years (mean 47.2 years). The etiology of massive hemoptysis in this series included bronchiectasis in 31 patients (58%), tuberculosis sequelae in eight (15%), necrotizing pneumonia in seven (13%), mycetoma in four (8%), and lung abscess in three (6%). Preoperative patient data that serve as predictors for emergency operation are shown on Table 1. Multivariate analysis using forward logistic regression identified cause of hemoptysis, age > 50 years, prior attacks of hemoptysis, and hypertension as independent predictors

Table 1
Preoperative factors in patients with massive hemoptysis

Variable	Emergency operation ($n = 27$)	Elective operation ($n = 26$)	Odds ratio	95% CI	<i>P</i> -value
Age (years) ^a	47 ± 10	45 ± 10			0.9
Age (≤ 50 years: > 50 years)	6:21	16:10	0.179	0.054–0.595	0.004
Sex (M:F)	15:12	15:11	1.091	0.368–3.235	0.8
Etiology					0.001*
Bronchiectasis	8	23			
Tuberculosis sequelae	7	1			
Necrotizing pneumonia	6	1			
Mycetoma	4	0			
Lung abscess	2	1			
Hypertension (Yes:No)	11:16	4:22	3.78	1.017–14.05	0.04
Diabetes mellitus (Yes:No)	6:21	2:24	3.42	0.624–18.84	0.1
Ischemic heart disease (Yes:No)	2:25	2:24	0.960	0.125–7.371	0.6
Hemoglobin < 10 g/dl (Yes:No)	17:10	8:18	3.825	1.221–11.981	0.02
Preop. blood transfusion (Yes:No)	14:13	9:17	2.034	0.673–6.146	0.1
Prior attacks of hemoptysis (Yes:No)	16:11	5:21	6.109	1.766–21.136	0.003

CI, confidence interval; Preop., preoperative. **P*-value for other groups versus bronchiectasis.

^a Mean ± standard deviation.

for emergency operation ($P < 0.05$). Blood transfusion was required in 23 patients (43%).

3.1. Previous hemoptysis

Twenty-one patients (40%) had a previous episode of hemoptysis, 16 of the 27 patients in group 1 and five of the 26 patients in group 2. The majority of previous attacks of hemoptysis were mild and occurred within 6 months of the patient's disease. These attacks were managed medically.

3.2. Distribution of the disease areas

The involved areas from which the hemorrhage originated could be localized precisely in 45 patients (85%) by localized radiologic findings, or a bronchoscope, or a combination of these (Table 2). In the remaining eight patients, the bleeding was identified from the right lung but the precise site could not be determined. The right and left lung was involved in 30 and 23 patients, respectively.

3.3. Surgical procedures

The operations performed are shown in Table 3.

3.4. Hospital outcome

Complications occurred in 13 patients (25%). These complications included sputum retention, which needed bronchoscopy aspiration in five patients; postoperative air leak for more than 2 weeks in four patients; pneumonia in two patients; postoperative bleeding that required reopening of the thorax in one patient; and bronchopleural fistula in one patient. Postoperative complications were more common in patients who received blood transfusion than non-transfused patients (9/23 and 4/30, respectively; $P = 0.03$). Five out of eight patients with hemoptysis secondary to tuberculosis had postoperative complications in comparison to all other patients ($P = 0.02$). Postoperative complications were more common in group 1 than group 2 (8/27 patients versus 5/26 patients) but the difference was statistically not significant ($P = 0.2$). There were two perioperative deaths. Cause of death in one patient was recurrent pulmonary hemorrhage with hypoxic cardiac arrest after emergency resection of the right middle lobe for bronchiectasis.

Table 2
Distribution of involved lung areas in 45 patients

Lobe	Number	%
Right upper	6	13
Right middle	9	20
Right lower	7	16
Left upper	6	13
Lingula	3	7
Left lower	14	31

Table 3
Type of pulmonary resection

Type of resection	Number (%)	Side/lobe
Pneumonectomy	1 (2)	Right = 1
Lobectomy	49 (92)	RUL = 6; RUL + RML = 3; RLL = 7; RLL + RML = 4; RML = 9; LUL = 6; LLL = 14
Segmental resection	3 (6)	Lingula = 3

RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; LUL, left upper lobe; LLL, left lower lobe.

The other patient had bronchopleural fistula postoperatively and died 3 months later due to respiratory failure.

3.5. Prognosis

Forty-nine out of 51 patients survived and had a follow-up of 3–6 years (mean 4.5 years) for all patients. Four patients (8%) had a recurrent episode of hemoptysis, three of which occurred within 1 year and were treated successfully with arterial embolization. One patient had a recurrent hemoptysis after 2 years and was successfully treated medically. All recurrences were from group 1 patients. The difference was statistically significant ($P = 0.02$). The four recurrences had occurred in patients with a diagnosis of bronchiectasis. These patients had recurrence of bronchiectasis; three patients after lower lobectomy, and one after lingulectomy. Their preoperative CT scan showed minimal evidence of disease in another part of the lung on the same side.

4. Discussion

Massive hemoptysis in this series and other series was most often due to bronchiectasis or other inflammatory lung disease [3,7,8]. Patients with acute or chronic inflammatory pulmonary disease have been shown to develop increased vascularity in the involved areas [2,4,7]. The chronic inflammation of bronchiectatic airway can lead to erosion of the airway wall and bronchial vasculature. Ongoing inflammation can then lead to disruption of the 'neovascularity' with resulting massive hemoptysis [3,4]. The diagnostic approach to patients with massive hemoptysis should be directed as efficiently as possible to determine the site of bleeding in order to provide rational treatment. The combined use of bronchoscopy and chest CT scan has the best yield in evaluating hemoptysis [9,10]. The timing of bronchoscopy in the evaluation of massive hemoptysis is controversial [4,5]. The presence of large amounts of blood within the bronchial tree makes visualization of the airways difficult. However, the poor prognosis in some patients who continue to have massive hemoptysis or whose hemoptysis recurs, suggest that the bronchoscopy be rapidly pursued.

In this series, a combination of rigid bronchoscopy with the passage of a flexible fiberoptic bronchoscope provide a good alternative to visualize the bleeding site in 45 patients (85%). Knott-Craig et al. [3] reported 43% localization of the bleeding site by rigid bronchoscopy. Ong et al. [11] have shown that bronchoscopy was able to identify the site of bleeding in about 90% of patients.

Surgery remains the definitive therapy for patients with massive hemoptysis and a localized lesion in suitable patients. Surgery is associated with the lowest mortality rate [1,2,12]. From the data in the literature, unless the source of bleeding is treated definitively during the hospital stay, the patient is at significant risk of recurrent bleeding [3,4]. Knott-Craig et al. [3] reported the risk of rebleeding to be 36.4% and resulted in death in 45% of the patients. Therefore, the timing of surgical intervention is crucial [1, 2]. Surgery is indicated on an emergency basis for the treatment of patients for whom pulmonary hemorrhage is life-threatening or not controlled by non-surgical interventions. Twenty-seven patients in this series underwent immediate surgery with two deaths; one from hypoxic cardiac arrest because of recurrent pulmonary hemorrhage and the other from bronchopleural fistula and respiratory failure. The argument in the literature against emergency surgery is that operation during bleeding crisis may precipitate emergency pneumonectomy and surgical mortality is related to ongoing hemorrhage at the time of pulmonary resection [2,7]. Thus, a rational approach to the management of patients with massive hemoptysis can be dictated by the rate of bleeding and localization of the lesion in a suitable surgical candidate. If the patient continues to bleed despite conservative measures, or if the patient suffers hypovolemic shock, or if adequate control of patient's airway and gas exchange cannot be maintained, then emergency surgery should be entertained.

The important factors to predict the type of treatment and outcome in massive hemoptysis are the rate at which the bleeding is occurring and the patient's underlying lung function [4]. The amount of blood loss during hemoptysis is not easy to measure. Therefore, other factors that predict the need for early operation were studied in this report. The persistence or recurrence of bleeding is predicted by the following factors: age > 50 years, hemoglobin < 10 g/dl on admission, prior history of hypertension and/or hemoptysis, and the underlying etiology of hemoptysis. This study identified patients with tuberculosis sequelae, a fungus ball, necrotizing pneumonia, and lung abscess as being at increased risk of bleeding. Endo et al. recommend early pulmonary resection if there is life-threatening hemoptysis, even after control of hemoptysis, when the following clinical features, chest CT scan, 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 [13]. Bleeding commonly originates from bronchial and/or extensive chest wall collaterals through pleural adhesions and fibrosis [13].

The alterations in bronchial arterial system and bleeding from multiple feeders in these inflammatory processes are well documented [13]. In those patients with cavitary lesions or necrotizing pneumonia, both factors may cause hemoptysis. The consensus from this study is that patients with previous predictors should be considered for early operation in an attempt to reduce the morbidity associated with blood transfusion.

Surgery is indicated on an elective basis for the definitive treatment of anatomically circumscribed lesions and in case of cessation of bleeding by conservative measures. The argument in this situation is that it is better to operate once the bronchial tree has been effectively cleared and the pulmonary parenchymal and pulmonary vasculature reserve recovered. Jougon et al. [7] reported a mortality rate of 27 and 0% for patients with massive hemoptysis operated on as an emergency and those operated on 1–3 weeks after cessation of bleeding, respectively. Twenty-six patients in this series for whom operation was delayed from 4 to 20 days after cessation of bleeding had no mortality.

Bronchial artery embolization (BAE) is a useful alternative therapy to control severe bleeding and results in an immediate termination of bleeding in 75–94% [6,7, 14]. In the study by Swanson et al. [6] an immediate control of bleeding was achieved with embolization in 51 of 54 patients (94%). Mal et al. [15] evaluated 56 patients who had been embolized for hemoptysis and noted that immediate control was achieved in 43 patients (77%). White et al. [14] suggest that BAE is a palliative procedure, and the potential for recurrent hemoptysis exists as long as the disease process is not cured by drug therapy or removed surgically. Recurrent bleeding occurs in 9–29% of patients after embolization [6,14,15]. Recurrences after BAE may be related to incomplete embolization, recanalization of the embolized vessels, revascularization of collateral vessels associated with the progression of the underlying disease, or bleeding that may be coming from a pulmonary artery branch which is eroded by a necrotizing process such as cavitary lesion of the lung [13]. In patients deemed too ill to undergo elective surgery, BAE may be repeated successfully for recurrent hemoptysis. However, this technique was not used in any of our patients with massive hemoptysis because of lack of experience of this technique in our unit. Recently this technique has become available in our center and is used in the treatment of recurrent hemoptysis after surgery.

Resectional surgery in massive hemoptysis is often complicated because of inflammatory lesions and by the presence of dense fibrous adhesions between the lung and the chest wall. Significant postoperative complications include bronchopleural fistula, postoperative pulmonary hemorrhage, lung infarction, wound infection, respiratory insufficiency, and hemothorax. The most significant of these complications is persistent bronchopleural fistula, which has been reported to occur in 10–14% of patients [4,8,12]. The morbidity in this series was 25% and is comparable to those

reported in the literature which varies between 15 and 30% [8,12,16]. Our results indicate that the morbidity was affected by preoperative blood transfusion and etiology of massive hemoptysis.

Four patients had recurrent hemoptysis in this series. All these recurrences were due to presence of mild bronchiectasis in another lobe and this progressed with time to cause hemoptysis. Most of the morphologic changes of bronchiectasis are heterogeneous and differ by location. Because postoperative deterioration of even slightly altered bronchi often occurs [16], complete removal of all significant areas of bronchiectasis must always be tried, even though the part of the lung seems less diseased. However, no reported recurrence after surgery was found in the literature.

5. Conclusions

Surgery remains the definitive therapy for patients with massive hemoptysis. Immediate operation must be performed in any case of massive hemoptysis, which is life-threatening, not controlled by non-surgical interventions and where the lesion is localized in a suitable patient. It might be possible to reduce complications if elderly patients with a prior history of hypertension and/or hemoptysis and bleeding due to a fungus ball, necrotizing pneumonia, tuberculosis or lung abscess were operated on at an early stage before they required blood transfusion.

References

- [1] Garzon AA, Cerruti MM, Golding ME. Exsanguinating hemoptysis. *J Thorac Cardiovasc Surg* 1982;84:829–33.
- [2] Conlan AA, Hurwitz SS, Krige L, Nicolaou N, Pool R. Massive hemoptysis. *J Thorac Cardiovasc Surg* 1983;85:120–4.
- [3] Knott-Craig CJ, Oosthuizen JG, Rossouw G, Joubert JR, Barnard PM. Management and prognosis of massive hemoptysis. *J Thorac Cardiovasc Surg* 1993;105:394–7.
- [4] Thompson AB, Teschler H, Rennard SI. Pathogenesis, evaluation, and therapy for massive hemoptysis. *Clin Chest Med* 1992;13:69–82.
- [5] Jean-Baptiste E. Clinical assessment and management of massive hemoptysis. *Crit Care Med* 2000;28:1642–7.
- [6] Swanson KL, Johnson CM, Prakash UBS, McKusick MA, Andrews JC, Stanson AW. Bronchial artery embolization. *Chest* 2002;121:789–95.
- [7] Jougon J, Ballester M, Delcambre F, Bride TM, Valat P, Gomez F, Laurent F, Velly JF. Massive hemoptysis: what place for medical and surgical treatment. *Eur J Cardiothorac Surg* 2002;22:345–51.
- [8] Lee TW, Wan S, Choy DK, Chan M, Arifi A, Yim AP. Management of massive hemoptysis: a single institution experience. *Ann Thorac Cardiovasc Surg* 2000;6:232–5.
- [9] McGuinness G, Beacher JR, Harkin TJ, Garay SM, Rom WN, Naidich DP. Hemoptysis; prospective high resolution CT/bronchoscopic correlation. *Chest* 1994;105:1155–62.
- [10] Hirshberg B, Biran I, Glaser M, Kramer MR. Hemoptysis: etiology, evaluation, and outcome in a tertiary referral hospital. *Chest* 1997;112:440–4.
- [11] Ong TH, Eng P. Massive hemoptysis requiring intensive care. *Intensive Care Med* 2003;29:317–20.
- [12] Garzon AA, Gourin A. Surgical management of massive hemoptysis. *Ann Surg* 1978;187:267–71.
- [13] Endo S, Otani S, Saito N, Hasegawa T, Kanai Y, Sato Y, Sohara Y. Management of massive hemoptysis in a thoracic surgical unit. *Eur J Cardiothorac Surg* 2003;23:467–72.
- [14] White RI. Bronchial artery embolotherapy for control of acute hemoptysis. *Chest* 1999;115:912–5.
- [15] Mal H, Rullon I, Mellot F, Brugiere O, Sleiman C, Menu Y, Fournier M. Immediate and long-term results of bronchial artery embolization for life-threatening hemoptysis. *Chest* 1999;115:996–1001.
- [16] Agasthian T, Deschamps C, Trastek VF, Allen MS, Pairolero PC. Surgical management of bronchiectasis. *Ann Thorac Surg* 1996;62:976–80.