Surgical Management of Massive Hemoptysis

A Ten-year Experience

ANTONIO A. GARZON, M.D.,* ANATOLE GOURIN, M.D.†

Pulmonary bleeding was defined as massive when the collected blood was 600 ml or more in 24 hours. Hemoptysis of this magnitude carries more than 50% mortality when managed without surgical intervention. For this reason all patients admitted, bleeding massively, in the past ten years were considered candidates for surgical therapy. Localization of the bleeding was done by bronchoscopy. Pulmonary reserve was evaluated by clinical and radiological observation and, when feasible, by spirometry. Of the 75 patients seen with massive hemoptysis, 68 were operated. Seven patients were excluded for various reasons. Five of these patients died during the acute bleeding episode. Sixty-five resections were performed with 11 deaths (17%) and three cavernostomies with one death. Of 51 lobectomies, seven expired (14%). One segmentectomy survived. Other than the magnitude of the surgical resection, the mortality was related to the amount of bleeding in the 24 hours preceding the surgical procedure. Severe bleeding at the time of resection requiring one-lung ventilation also significantly influenced the mortality (33% against 7%). This experience shows that pulmonary resection is the treatment of choice in patients with massive hemoptysis.

From the Department of Surgery/Downstate Medical Center and Kings County Hospital Center, Brooklyn, New York

HEMOPTYSIS IS A SYMPTOM of cardiopulmonary disease and usually only requires medical therapy. On occasions, bleeding becomes massive and the patient may suffocate in his own blood. It is rare to see any patient die of exsanguination. The incidence of massive pulmonary bleeding is difficult to ascertain in the medical literature. In the ten-year experience involved in this study, there were approximately 18,000 admissions to the Pulmonary Medical Service of Kings County Hospital Center. Of them, only 75 patients were considered to be bleeding massively. This figure represents less than 0.5% of all admissions.

The definition of massive pulmonary bleeding has not been completely agreed upon. However, in the past ten years many of the authors publishing on this subject seem to agree that a patient who bleeds 600 ml in 24 hours has massive hemoptysis. We have accepted this arbitrary amount of blood loss as the definition of massive bleeding.

In the middle of the last decade a dedicated group of pulmonary disease specialists started to study closely those patients admitted with massive hemoptysis to the Pulmonary Medical Service of Kings County Hospital. The results of these observations have been published elsewhere, but it is worth mentioning that patients bleeding 600 ml in 16 hours had a 75% chance of dying of the hemoptysis when managed conservatively.[1] These statistics were the impetus necessary to start an aggressive and systematic surgical therapy in patients with massive pulmonary bleeding. Since then, all patients admitted with massive hemoptysis have been evaluated for surgical therapy and the majority of them have been operated upon, except for a few patients who were rejected because of very poor pulmonary functions. Our experience with the management of these patients is the basis for this report.

Materials and Methods

This study covers the period between the beginning of 1966 and the end of 1975. All patients admitted to the Medical Service with measured hemoptysis of 600 ml in 24 hours were considered candidates for pulmonary resection. An emergency surgical consultation was obtained and a bronchoscopy was done during the active bleeding to localize the source of the bleeding. Seventy-five patients were evaluated by the Surgical Service. Seven patients were considered not suitable for surgical intervention and were treated medically. Four of these patients died of massive bleeding and one of subsequent infection and renal failure. Two survived

* Professor of Surgery, Downstate Medical Center.

† Deceased.

Reprint requests: Dr. Garzon, St. Vincent's Medical Center of Richmond, 355 Bard Avenue, Staten Island, New York 10310.

Submitted for publication: July 16, 1977.

0003-4932-78-0300-0267-0075

TABLE 1. *Surgical Management of Massive Hemoptysis*

Diagnosis	No. of Patients	%
Tuberculosis		
Active	33 (25)	49
Inactive	15 (10)	22
Bronchiectasis	8 (8)	12
Lung Abscess	5 (5)	7
Carcinoma	3 (2)	4
Others	4 (4)	6
Sarcoma, Actinomycosis, Fibrosing Mediastinitis, A.V. Fistula?		
Total	68 (54)	100%

( ) Number of patients actively bleeding at the time of the operation.

the hospitalization, and were well and alive four and three years later. Of the remaining 68 patients, 65 had a pulmonary resection and three patients had a cavernostomy to control the bleeding. The criteria for inoperability were: pulmonary function with vital capacity of less than 40% of predicted, or a force expiratory volume of less than 40% in the first second; unresectable carcinoma and bilateral pulmonary disease with inability to localize the site of bleeding by bronchoscopy.

The age of our patients ranged from 16 to 74 with an average of 44 years. There were 21 women and 47 men. Fifty-four patients were bleeding at the time of the pulmonary resection. The rest of the patients had ceased bleeding at the time of the operation. Almost all of the surgical procedures were performed within the first 24 hours of the main massive episode of bleeding. In 25 patients, the bleeding was so masive at the time of the pulmonary resection that they required single-lung anesthesia to avoid drowning. At the beginning of this study, double lumen Carlens tubes were used in seven patients; five of them had massive aspiration of the contralateral lung. Blood aspirations ended fatally in all these patients. Double lumen tubes were substituted by bronchial intubation or balloon catheter block of the bleeding bronchus.

This method was used in 18 patients and proved most effective to protect the nonbleeding lung from aspiration. Only three patients in this group showed contralateral aspiration in the postoperative chest roentgenograms and only one died of respiratory and renal failure. Our methods to control aspiration of blood have been described previously.[2] However, some of the main features will be briefly included. When bleeding from the left lung, the procedure of choice is to block the left main stem bronchus with a Fogarty occlusion catheter size 8/14 French 89 cm long and equipped with a balloon catheter of 10 ml capacity. The catheter is introduced under topical anesthesia into the left main stem bronchus under direct vision through a bronchoscope. A thin plastic or rubber tube, 20–40 cm long, is interposed between the proximal end of the hub and the Luer Lock fitting of the Fogarty catheter. These extra length of tube allow for removal of the bronchoscope without pulling out the Fogarty catheter. The balloon of the Fogarty catheter is filled with radiopaque material. After the bronchoscope is removed, an endotracheal tube is placed and its cuff is inflated. These help to hold the Fogarty catheter against the wall of the trachea and avoid displacement of the balloon. Then the patient is given general anesthesia and positioned for a left posterolateral thoracotomy. We recommend that a chest x-ray be taken at this time to check the proper position of the balloon in the main stem bronchus, to be sure that the blocking catheter has not been displaced during the change of the patient's position. The catheters will rarely move therafter. However, the anesthesiologist should be well aware of that possibility. A displaced and inflated balloon catheter can produce obstruction of the trachea or the right main bronchus and should be deflated as soon as such a possibility is suspected.

When bleeding is coming from the right lung, we favor the introduction of a long endotracheal tube into the left main stem bronchus, and proceed with the left lung anesthesia. The patient should be placed in a moderate Trendelennburg position to facilitate the exit of blood from the bleeding right lung and to avoid accumulation in the distal bronchial tree. Sometimes it is difficult to advance an endotracheal tube into the left main stem bronchus. Under those circumstances, the right main stem bronchus and the right upper lobe bronchus can be blocked with a Fogarty catheter as described previously for the left side bleeding. Displacement of the catheter is more common in this position because of the short right main stem bronchus. Packing the bleeding bronchus with a long piece of gauze is dangerous since the gauze easily becomes displaced and may obstruct the nonbleeding lung.

The etiologic diagnosis of the hemoptysis is shown in Table 1. Pulmonary tuberculosis was the cause of bleeding in 48 patients: of them, 33 had acid-fast bacilli recovered from the tissue or sputum cultures. Fourteen patients with positive acid-fast bacilli had not received antituberculosis therapy before the pulmonary resec-

TABLE 2. *Average Value of Ventilatory Tests*

Test	Number of Patients	Per Cent of Predicted Normal
V.C.	37	64
F.E.V.	32	59
M.V.V.	17	72

V.C.—Vital capacity. F.E.V.—Forced expiratory ventilation on the first second. M.V.V.—Maximal voluntary ventilation.

tion. More than two-thirds of the patients with pulmonary tuberculosis were actively bleeding when operated. In eight patients, bronchiectasis was the source of the bleeding and all of them were bleeding when resected. All the five patients with lung abscesses were bleeding at the time of the operations. Three patients had carcinoma—two bronchogenic and the third metastatic. Four more patients had miscellaneous conditions.

Ventilatory studies were not performed in 31 patients because they were unable to cooperate due to continuous bleeding during the entire preoperative period. The average vital capacity (V.C.) in 37 patients was 64% of the predicted value. The forced expiratory ventilation (F.E.V.) in the first second in 32 patients had an average value of 59% of predicted. The maximal voluntary ventilation was measured in only 17 patients; it was 72% of the predicted (Table 2).

Results

Twelve patients died following surgical procedures for massive hemoptysis during the hospitalization period. This represents 15.5% total mortality (Tables 3 and 4)

Pneumonectomies

Ten pneumonectomies were performed for tuberculosis and three for other conditions: four patients died (30%). Three patients died during the surgical procedure. One, with active tuberculosis, had a massive aspiration and cardiac arrest during the induction of anesthesia. He was resuscitated and a pneumonectomy was performed but he died on the operating table. Another patient with active tuberculosis had a massive aspiration before the operation and died in the operating room during the performance of a pneumonectomy. The third patient, with a very large lung abscess, died during the operation from uncontrolable bleeding. The last fatality was a patient with active tuberculosis who developed a bronchopleural fistula and died six weeks after the pneumonectomy of bleeding from the pulmonary artery. All these fatalities occurred early in our experience. The two aspiration deaths resulted in patients anesthetized with double lumen Carlens tube.

TABLE 3. *Results of Surgery*

Type of Operation	Number	Diagnosis	Mortality		
			Operative	Post-op	Total
Pneumonectomy	10	Tuberculosis	2	1	3
	3	Nontuberculosis	1	—	1
Lobectomy	34	Tuberculosis	—	4	4
	18	Nontuberculosis	1	2	3
Cavernostomy	3	Tuberculosis	—	1	1
	—	Nontuberculosis	—	—	—
Total	68		4	8	12

TABLE 4. *Cause of Death on Pulmonary Resection*

Diagnosis	Operation	Cause of Death
Active Tuberculosis	Pneumonectomy	Operative Bleeding and Aspiration
Active Tuberculosis	Pneumonectomy	Bronchopleural Fistula and Empyema (Postoperative Day 38)
Active Tuberculosis	Lobectomy (R.U.L.)	Preoperative Aspiration—Respiratory Failure (Postop Day 23)
Active Tuberculosis	Lobectomy (R.U.L.)	Diabetic Acidosis (Postop Day 12)
Active Tuberculosis	Cavernostomy	Aspiration—Respiratory Failure (Postop Day 2)
Inactive Tuberculosis	Pneumonectomy	Operative Aspiration and Asphyxia
Inactive Tuberculosis	Lobectomy (L.U.L.)	Delirium Tremens, Liver Failure (Postop Day 18)
Inactive Tuberculosis	Lobectomy (R.U. & Middle Lobe)	Bronchopleural Fistula, Empyema, Respiratory Failure (4th Month Postop)
Inactive Tuberculosis	Lobectomy	Bleeding Stress Ulcer (Postop Day 8)
Lung Abscess	Pneumonectomy	Operative Bleeding and Aspiration
Bronchiectasis	Lobectomy (R.L.L.)	Respiratory Failure (Postop Day 1)
Lung Sarcoma	Lobectomy (R.L.L.)	Renal Failure (Postop Day 20)

Lobectomy Group

Thirty-four lobectomies were performed for massive bleeding in patients with pulmonary tuberculosis. Twenty-three had active tuberculosis demonstrated by positive sputum culture. Fourteen patients with acid-fast bacilli in the sputum were operated without effective antituberculous therapy. All the rest of the patients had at least two weeks of adequate antituberculous treatment. Four patients with tuberculosis died after lobectomies. One patient had an episode of anoxia with convulsions before the operation. She was operated comatose and never recovered of her neurological deficit and died three weeks postoperatively of respiratory failure. Another patient died 18

TABLE 5. *Postoperative Complications in 57 Surviving Patients*

Type of Complication	Number of Patients			
	Pneumo-nectomy	Lobec-tomy	Caver-nostomy	Total
Aspiration	1	9	1	11
Tracheostomy	4	10	1	15
Respiratory Insufficiency	—	4	—	4
Re-exploration (Pleural Bleeding)	1	2	—	3
Bronchopleural Fistula	1	5	—	6
Thoracoplasty	1	5	1	7
Total Complications	8	35	3	46

days following the operation of liver failure and delirium tremens. The third patient, a well-known diabetic, died 12 days after an upper lobectomy, probably of diabetic acidosis. The last patient, with inactive tuberculosis, developed a bronchopleuro fistula, respiratory failure and died four months after the operation.

There were 18 lobectomies for bronchiectasis, lung abscesses and other conditions, with two deaths. One patient with bronchiectasis died shortly after a right lower lobectomy of massive aspiration and hypoxia. The other patient, with lung sarcoma, died the twenty-first postoperative day following a left upper lobectomy, of renal failure. The total mortality rate for lobectomy was 13%.

Cavernostomy

Of the three patients who had cavernostomy for hemoptysis, one patient died three days postoperatively of respiratory failure brought about by poor pulmonary reserve and blood aspiration.

Complications

The postoperative complications of 57 surviving patients are shown in Table 5. Aspiration pneumonitis was seen in the postoperative chest roentgenogram of 11 patients. Small areas of atelectasis were frequently found in the postoperative period but they cleared with the usual respiratory care and they are not included as complications.

Tracheostomy was necessary in 15 patients, in most of the cases to remove aspirated blood. Most of the tracheostomies were performed in the first part of this study. Later, most of the aspiration problems were managed with endotracheal intubation. Four patients had respiratory failure lasting for several days, requiring respiratory support.

Two patients were re-explored for intrapleural bleeding in the immediate postoperative period. One patient, 12 days after a lobectomy, developed massive bleeding from the stump of a branch of the pulmonary artery. He was reoperated, the bleeding controlled, and he survived.

Five patients after lobectomy developed bronchopleuro fistula and required tailoring thoracoplasty to close the fistula and to obliterate the pleural space. One patient with a pneumonectomy developed a bronchopleuro fistula and needed an extensive thoracoplasty. Finally, one patient with a cavernostomy required localized thoracoplasty to close the residual cavity.

Comments

Massive hemoptyses are a rare complication of several common pulmonary diseases, mainly chronic inflammatory processes. In our experience, conservative management carries a very high mortality in patients bleeding 600 ml or more in 24 hours. Surgical treatment has been shown to improve those results and is becoming widely accepted as the treatment of choice.[3,4]

There seemed to be no question that in institutions with well-trained thoracic surgeons, adequate operating room facilities and experienced anesthetists, the treatment of choice is resection of the bleeding source. There will always be some patients with poor pulmonary functions or terminal cancer who will not be candidates for resection. However, this number is relatively small. In our series only seven patients out of 75 were included in that category. For some time it was felt that the inability to locate the site of the bleeding would be a contraindication for surgical therapy, but the location of the site of the bleeding was not a problem in our patients. To localize the site of the bleeding, bronchoscopy must be done when there is active bleeding. In a few instances, bleeding increased during the bronchoscopy and the surgeon should be prepared for this eventuality. All patients scheduled for bronchoscopy when bleeding should have blood available for transfusion and the bronchoscopy should be done with the open rigid bronchoscope. In case of massive bleeding the open

TABLE 6. *Effect of Massive Bleeding on Mortality*

Bleeding During Pulmonary Resection	Number of Patients	Mortality	
		Aspiration	Total
Massive Unilateral Ventilation	24	5 (21%)	8 (33%)
Minimal Bilateral Ventilation	41	2 (5%)	3 (7%)
Total	65	7 (11%)	11 (17%)

scope can be used as an airway to maintain aeration of the nonbleeding lung. Commonly, the increased bleeding that appeared during bronchoscopy subsided quickly. However, when it does not stop a blocker can be introduced under direct vision to isolate the site of the bleeding and the patient should be operated without delay. Therefore, operating room facilities and personnel should always be ready in these circumstances. An experienced anesthetist is of great help in this situation. There is no role for fiberoptic bronchoscopy in a patient bleeding massively. The fiberoptic bronchoscope quickly becomes covered by blood making any inspection of the bronchial tree impossible. During bronchoscopy it is a good idea to have two complete suction sets working all the time. Patients with massive hemoptysis do not die from blood loss, but by suffocation. To prevent suffocation during the bleeding, two sets of suction machines are extremely helpful.

About four-fifths of our patients had inflammatory lesions as the source of bleeding and in about two-thirds, the etiology of the lesions was tuberculosis. Half of our patients were operated with active tuberculosis and almost half of them had pulmonary resection without previous antituberculous therapy. Our results indicate that the mortality was not affected by the etiology, activity of tuberculosis, lack of therapy nor patient age or sex. A factor that influenced the mortality was the amount of bleeding in the preoperative period. The average recorded blood loss in 54 survivors was 450 cc in the preceding 12 hours. In the 12 mortalities, the average measured blood loss in the same period was 800 cc.

A most significant factor in morbidity and mortality following resection for massive bleeding was the aspiration of the blood into the contralateral lung. In 24 patients that were bleeding massively at the time of the operation and required single-lung ventilation, eight patients died or 33% mortality. In 41 pulmonary resections in whom the hemoptysis was not large enough to require single-lung ventilation, only three patients died (7% mortality) (Table 6).

The combination of massive, continuous bleeding and pneumonectomy carries a very poor prognosis. At present, we feel that such a patient should be operated as soon as possible, even before he reaches the 600 ml of blood loss that is considered massive hemoptysis. Lobectomy patients had an operative mortality of less than half of the pneumonectomies. If a patient that has bled 600 ml in the previous 24 hours stops bleeding, he should be operated as soon as possible before bleeding starts again. This is the best time to remove the cause of bleeding. Naturally, it is necessary to localize the site of the bleeding before the offending lesion can be removed. This is the reason for recommending bronchoscopy when the bleeding is active.

Cavernostomy is not the operation of choice to stop hemoptysis and should be reserved to those few instances when there is a large cavity in a patient with very poor pulmonary functions and massive bleeding. This patient will not be a candidate for resection and a cavernostomy with cauterization of the bleeding point and packing of the cavity can control the hemoptysis. Bronchocutaneo fistula is a very common complication of cavernostomy. To close the fistula and cavity, a thoracoplasty is needed frequently.

As far as we know, this is the largest published series on the surgical management of massive hemoptysis. This ten year experience confirms our earlier opinion that the pulmonary resection is the treatment of choice for patients with massive hemoptysis. The overall mortality for resected surgery was 17% as compared with more than 50% with medical management.

References

1. Crocco, J. A., Rooney, J. J., Fankuahen, D. S., et al.: Massive Hemoptysis. Arch. Intern. Med., 121:495, 1968.
2. Garzon, A. A., Cerruti, M., Gourin, A. and Karlson, K. E.: Pulmonary Resection for Massive Hemoptysis. Surgery, 67: 633, 1970.
3. Gourin, A. and Garzon, A. A.: Control of Hemorrhage in Emergency Pulmonary Resection for Massive Hemoptysis. Chest, 68:120, 1975.
4. Gourin, A. and Garzon, A. A.: Operative Treatment of Massive Hemoptysis. Ann. Thoracic Surg., 18:52, 1974.
5. Thoms, N. W., Wilson, R. F., Puro, H. E. and Argulu, A.: Life Threatening Hemoptysis in Primary Lung Abscess. Ann. Thorac. Surg., 14:173, 1972.