Immediate and Long-term Results of Bronchial Artery Embolization for Hemoptysis Due to Benign Versus Malignant Pulmonary Diseases

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Abstract: *Background:* Bronchial artery embolization (BAE) is widely used for the treatment of hemoptysis. The immediate and long-term results of BAE for hemoptysis in patients with benign and malignant pulmonary diseases were inconsistent in previous studies and were thus investigated. *Methods:* This was a retrospective review of the clinical records of 154 patients (108 with benign disease and 46 with malignant disease) who received BAE for hemoptysis from January 2005 to June 2011 at the Chinese People's Liberation Army General Hospital. *Results:* Immediate cessation of hemoptysis was achieved in 98 patients with benign disease (90.7%) and 42 patients with malignancy (91.3%). The long-term control rate of hemoptysis in patients with benign disease was 74.3% (80/108) at 1 year, significantly higher than in patients with cancer (16/46, 35.5%, $P < 0.01$). The worst outcomes in the benign and malignant groups were observed in patients with aspergilloma and squamous cell lung cancer, respectively. The average number of abnormal vessels on bronchial arteriography was higher in the benign group than in the malignant group (3 ± 1.3 versus 2 ± 1.1, respectively, $P < 0.01$). Moreover, recurrent hemoptysis was independently associated with the presence of massive hemoptysis and bronchial-pulmonary artery shunt in both groups ($P < 0.05$). *Conclusions:* BAE is a relatively safe procedure for patients with hemoptysis. Immediate control of hemoptysis with BAE is achieved in most cases, but the long-term hemoptysis control rate is worse in malignant lung diseases than in benign conditions, especially among patients with squamous cell lung cancer.

Key Indexing Terms: Hemoptysis; Bronchial artery; Embolization; Lung cancer. **[Am J Med Sci 2014;348(3):204–209.]**

Massive hemoptysis is a life-threatening medical emergency that requires prompt investigation and management. Conservative management in massive hemoptysis carries a 50% to 100% mortality rate.[1,2] Although surgery is thought to yield better outcomes, postoperative mortality rates among patients undergoing emergency surgery have been reported to be as high as 40%.[3] First described in 1974, bronchial artery embolization (BAE) is a well-accepted and widely used procedure for patients with hemoptysis whose bleeding are resistant to conservative management, who refuse surgery or who are not candidates for surgery (due to poor lung function, bilateral pulmonary disease or medical comorbidities) or other surgical contraindications.[4–8]

The effectiveness of BAE in the management of hemoptysis is well documented.[2,5,8,9] Although the immediate control of hemoptysis with BAE is achieved in most cases, the long-term hemoptysis control rates are variable in the literatures and recently have been reported to be influenced by the etiology of hemoptysis.[4,6,7] Bronchiectasis, tuberculosis, pneumonia and lung cancer are the main causes of hemoptysis. In particular, it is estimated that lung cancer is the cause of hemoptysis in approximately 30% of cases. Reportedly, up to 30% of lung cancer patients will develop hemoptysis and, of these, 10% will experience massive hemoptysis.[10,11]

However, most of the reports about BAE for hemoptysis only focused on patients with benign lung diseases,[2,5,8,9] and research on the effectiveness of BAE among cancer patients as a separate subgroup is rare. Consequently, the clinical utility of BAE in cancer patients with hemoptysis is less well established than BAE in patients with benign causes of hemoptysis.

Therefore, the aim of this study was to evaluate the immediate and long-term results of BAE for hemoptysis in patients with benign and malignant pulmonary diseases and to identify significant prognostic factors for recurrent hemoptysis in these patients.

METHODS

Population Selection

This was a retrospective review of consecutive patients admitted to our hospital because of hemoptysis. From January 2005 to June 2011, 208 patients underwent BAE to treat hemoptysis. Of these patients, 154 patients, consisting of 121 males and 33 females, were selected for the study. The mean age was 57.4 years (range, 16–85 years). The exclusion criteria for the study were as follows: (1) definitive diagnosis not established during follow-up (14 cases); (2) bleeding originating from the pulmonary supply, such as pulmonary arterio-venous malformations, pulmonary venous thromboembolism, etc. (8 cases); (3) embolization other than gelatin sponge particles and/or polyvinyl alcohol (PVA) microspheres (20 cases); and (4) patient lost to follow-up or status of hemoptysis unable to be verified for 12 months after BAE (12 cases).

Patients were divided into 2 groups (benign and malignant disease) according to the cause of hemoptysis. In the benign group (n = 108), the underlying etiologies of hemoptysis were as follows: bronchietasis (n = 67), bacterial pneumonia (n = 11), active tuberculosis (n = 9), inactive tuberculosis (n = 7), aspergilloma (n = 5), pneumonia abscess (n = 5), chronic bronchitis (n = 3) and nontuberculosis mycobacterial infection (n = 1). In the malignant group (n = 46), the underlying etiologies of hemoptysis were primary bronchogenic carcinoma (n = 40) and pulmonary metastatic cancer (n = 6). The histologic subtypes in the 40 patients with primary bronchogenic carcinoma were as follows: squamous cell cancer (n = 22), adenocarcinoma (n = 9), small cell lung cancer (n = 5) and unspecified (n = 4).

A review of patient medical records and telephone interviews with patients were used to investigate the underlying

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cause of hemorrhage, volume of hemorrhage, angiographic appearance of the lesion at the time of embolization, number and type of embolized arteries, embolic agents and treatment complications as well as to obtain follow-up information about the condition of patients included in this study. The volume of hemorrhage at angiography was classified as mild (blood-tinged sputum), moderate (frank blood <300 mL/24 hr), massive (frank blood >300 mL/24 hr).[11] For each patient, the end of follow-up was defined as June 2012 (for patients for whom the date of follow-up was available) or the date of death. The follow-up time ranged from 3 days to 74 months (mean 19.5 months for all patients, 24.2 months for patients in the benign group and 8.1 months for patients in the malignant group). The study was approved by the Ethics Committee of the Chinese People's Liberation Army General Hospital. Chest computed tomography (CT) scanning was performed before angiography in 146 patients (95%), and the findings were abnormal in all patients. In 119 patients (82%), the findings of CT scans were suggestive of the causes of hemoptysis, and in 103 patients (71%) they were suggestive of the site of hemorrhage. Bronchoscopy was performed before angiography in 82 patients (53%). It identified the source of bleeding in 61 patients (74%) and was not helpful in 21 patients (26%). All patients received standard medical management and supportive care.

BAE Technique

All the BAE procedures were performed by the same interventional radiologist with 8 years of experience, following a thorough consultation with the referring pulmonologist, thoracic surgeon and radiologist. BAE was performed during active bleeding or immediately after the cessation of bleeding. Before each procedure, the patients were asked to sign informed consents. During the procedure, patients received either local anesthesia only or monitored, moderate sedation. The modified Seldinger technique was used for femoral artery puncture, and a 5F arterial sheath was inserted. The 5F-4F-3F Simmons I catheters (Cordis Corp, Hialeah, FL) were inserted up to the level of the thoracic aorta, and selective bronchial artery angiography was performed. A thorough search for abnormal nonbronchial arteries (such as the internal mammary artery, inferior phrenic artery or intercostal artery) was also routinely performed. Embolization was superselective if abnormal vessels were identified. A number of different 4F guiding catheters or 3F microcatheters (Renegade Boston Scientific Corp, Fremont, CA) were used in patients who underwent BAE. The choice of which embolic material to use was made by the interventional radiologist performing the procedure based on the results of angiography. The embolic agents used were gelatin sponge particles, PVA microspheres (Boston Scientific Corp, Fremont, CA) and a combination of the 2 materials. The sizes of PVA microsphere used were 300 to 500 μm and 500 to 700 μm. Pulmonary angiography was not routinely performed. Vital signs, including oxygen saturation, were continuously monitored during the procedure for all patients.

Data Collection

Immediate success was defined as cessation of hemoptysis after the first embolization, whereas treatment failure was defined as persistence of hemoptysis after the first embolization. Long-term outcomes were assessed by cumulative hemoptysis nonrecurrence rates, and recurrence of hemoptysis was defined as expectoration of clot or fresh blood.[2]

SPSS 16.0 (SPSS, Chicago, IL) was used for statistical analysis. Pearson's χ^2 or Fisher's exact tests were used to analyze categorical variables between groups, and Student's t test was used to compare continuous variables. The time to recurrence of hemoptysis was calculated with using the Kaplan-Meier test. Cox regression analysis was used to evaluate potential risk factors for recurrence. A 2-tailed P value of <0.05 was considered statistically significant.

RESULTS

Outcomes of All Patients

A total of 154 patients underwent 178 BAE procedures; of these, 154 procedures were the initial BAE, 22 were repeat procedures and 2 were the third procedure. In all the cases, bronchial or nonbronchial arteries were found to be abnormal with tortuosity, hypertrophy, bronchial-pulmonary shunting, extravasation of contrast material or peribronchial hypervascularization. The average number of arteries embolized per procedure was 2.7 ± 1. As shown in Figures 1A and 1B, immediate control of hemoptysis was achieved in 140 of the 154 patients who underwent bronchial embolization. BAE failed to control bleeding in 14 patients. Three of these patients died of massive hemoptysis within 1 week after the procedure, and 1 patient underwent emergency surgery. Repeat embolization was performed in another 10 patients. In 6 of these patients, repeat BAE was successful. One patient underwent emergency surgery, and 2 patients underwent elective surgery after the repeat BAE. A patient with aspergilloma and bronchietasis underwent a third BAE. However, this patient's hemoptysis was not controlled even after repeat surgery, and the patient died. Figure 2A illustrates the Kaplan-Meier analysis of immediate and long-term results of our study cohort. Cumulative hemoptysis control rates after initial BAE were 88.3% at 1 month, 84.2% at 6 months, 66.1% at 1 year, 54.9% at 3 years and 43.9% at 6 years.

Outcomes Comparison Between Benign and Malignant Lung Diseases Groups

Immediate cessation of hemoptysis was achieved in 98 patients in the benign group (90.7%) and 42 patients in the malignant group (91.3%). The long-term hemoptysis control rate in the benign group was 74.3% (80/108) at 1 year, significantly higher than in the malignant group (16/46, 35.5%, $P < 0.01$). The difference in the cumulative hemoptysis control rate according to the Kaplan-Meier test between the 2 groups was also statistically significant ($P = 0.000$), as shown in Figure 2B. We also compared the clinical characteristics of patients in the benign and malignant groups, as shown in Table 1.Trivial hemoptysis was more common in the malignant group than in the benign group ($P = 0.000$). The average number of abnormal vessels on bronchial arteriography in the malignant group was 2 ± 1.1 significantly less than the 3 ± 1.3 abnormal vessels observed in the benign group ($P = 0.001$).

Comparison of Outcomes in Patients With and Without Recurrent Hemoptysis

In this study, 66 (42.9%) patients needed re-admission because of continuing hemoptysis (recurrent group), whereas 88 (57.1%) patients stopped bleeding during the follow-up period (nonrecurrent group). The clinical characteristics of these 2 groups were analyzed, including sex, underlying pulmonary disease and angiographic appearance. Statistical correlations between these factors and the risk of recurrent hemoptysis were also assessed, as shown in Table 2. Patients with aspergilloma or squamous cell lung cancer were more frequent in the recurrent group ($P = 0.003$ and 0.033, respectively). In addition, the presence of bronchial-pulmonary artery shunt was also more