CLINICAL STUDY

Safety and Efficacy of Repeat Embolization for Recurrent Hemoptysis: A 16-Year Retrospective Study Including 223 Patients

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ABSTRACT

Purpose: To assess safety, efficacy, and long-term outcome of repeat bronchial artery embolization (BAE) for recurrent hemoptysis.

Materials and Methods: This was a retrospective study of patients referred for repeat BAE to manage recurrent hemoptysis after initial successful embolization. BAE was performed in 223 patients; 36 (16.1%) of these patients underwent 59 repeat BAE procedures because of recurring symptoms. The most frequent underlying lung diseases were bronchiectasis (n = 8; 22%), cystic fibrosis (n = 7; 19%), and idiopathic hemoptysis (n = 7; 19%).

Results: Most patients (64%) underwent 2 embolization procedures owing to vessel recanalization (71%) as the most frequent pathophysiologic mechanism of recurrent hemoptysis. No serious adverse events requiring prolonged hospital stay were noted. Risk for relapse of hemoptysis was significantly lower for bronchiectasis compared with other chronic infections ($P = .0022$) and cystic fibrosis ($P = .0004$). Overall survival after 3-year and 5-year follow-up was 92% and 84%, respectively.

Conclusions: Repeat BAE for recurrent hemoptysis after initial successful BAE is safe and efficacious, especially in patients with bronchiectasis as the underlying lung disease.

ABBREVIATIONS

BAE = bronchial artery embolization, PVA = polyvinyl alcohol

Hemoptysis can be a life-threatening symptom that may be related to serious underlying pulmonary diseases (1). Bronchoscopy can be used for diagnosis and localization of bronchial bleeding. Transcatheter embolization of the bronchial arteries has become the most effective nonsurgical treatment in the management of massive and recurrent hemoptysis, whereas surgery still is performed in fit patients when hemoptysis is associated with resectable pulmonary lesions, such as selected cases of aspergilloma and benign or malignant lung tumors (1–3). However, a limitation of bronchial artery embolization (BAE) is the relatively high recurrence rate, which is 10%–55% (3). This is not surprising, as BAE can be considered as a therapeutic interventional procedure for symptomatic control of hemoptysis without addressing the underlying disease process. This retrospective study analyzed the outcome, including safety and efficacy, of repeat BAE in patients with recurrent hemoptysis after previous successful BAE as well as clinical parameters potentially predicting early or late recurrence of hemoptysis despite technically successful BAE.

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MATERIALS AND METHODS

Study Design and Patient Population

This retrospective study included all patients referred between January 1998 and January 2014 to the interventional radiology department of a single institution for repeat embolization of the bronchial arteries to manage recurrent hemoptysis. Clinical indication for referral to embolization

was ≥ 250 mL of hemoptysis over 24 hours. All patients gave informed consent before the embolization procedure, and approval from the local ethics committee was obtained for retrospective study analysis.

From January 1998 to January 2014, 223 patients underwent BAE for management of persistent hemoptysis; 36 patients (16.1%) presented with relapse of symptoms of hemoptysis, requiring ≥ 1 BAE procedures. In these 36 patients, 59 BAE procedures were performed. Patients' demographic data, number of BAE procedures performed per patient, and underlying lung diseases are summarized in Table 1.

Demographic data were collected from the patients' electronic medical records. Underlying lung diseases of patients were categorized into 4 groups: group 1, bronchiectasis; group 2, cystic fibrosis; group 3, chronic infection and/or inflammation, including aspergillosis, tuberculosis, lung abscess, and post–radiation therapy lung disease; and group 4, other diseases, including congenital heart disease, chronic obstructive pulmonary disease, lung fibrosis, bronchial aneurysm, chronic thromboembolic pulmonary hypertension, and idiopathic. Images were reviewed using hard copies (January 1998 to July 2001) or studies stored on the institutional picture archiving and communication system workstation (IMPAX; Agfa Healthcare, Mortsel, Belgium) (July 2001 to January 2014). Repeat BAE was defined as a second, third, or more embolization procedure to manage hemoptysis that recurred after an earlier successful BAE.

Table 1. Patients' Demographics, Number of BAE Procedures and Underlying Lung Diseases (N = 36 Patients)

Variables	Values
Sex, n (%)	
Male	19 (52.8%)
Female	17 (47.2%)
Age at first BAE, y	
Mean	49.8
SD	20.26
Median	55.0
IQR	31.5–64.5
Range	5.0–80.0
Number of BAE procedures, n (%)	
2	23 (63.9%)
3	6 (16.7%)
4	5 (13.9%)
5	1 (2.8%)
6	1 (2.8%)
Underlying lung disease, n (%)	
Bronchiectasis	8 (22.2%)
Cystic fibrosis	7 (19.4%)
Idiopathic	7 (19.4%)
Congenital heart disease	3 (8.3%)
Tuberculosis	3 (8.3%)
COPD	2 (5.6%)
Aspergillosis	1 (2.8%)
Bronchial aneurysm	1 (2.8%)
CTEPH	1 (2.8%)
Lung fibrosis	1 (2.8%)
Chronic lung abscess	1 (2.8%)
Post–radiation therapy	1 (2.8%)

BAE = bronchial artery embolization; COPD = chronic obstructive pulmonary disease; CTEPH = chronic thromboembolic pulmonary hypertension; IQR = interquartile range.

Bronchial Artery Angiography and Embolization

BAE, including initial and repeat procedures, was performed by 3 interventional radiologists with a mean experience of 13 years (10, 12, and 17 years, respectively) after resuscitation and clinical stabilization of the patient, including hemodynamic and respiratory support and correction of coagulation abnormalities. Computed tomography angiography was not routinely performed before BAE. All BAE procedures were performed in a dedicated angiography suite under continuous monitoring of the patient's vital signs by experienced staff interventional radiologists with > 10 years of experience in BAE. After gaining vascular access in the right common femoral artery with a 5-F sheath under local anesthesia, selective catheterization of the bronchial arteries arising from the aorta was performed with a 5-F bronchial artery catheter (Djindjian catheter; Cordis Europa N.V., Roden, Netherlands, or Performa catheter; Merit Medical Systems, Inc, South Jordan, Utah). A microcatheter (Progreat 2.7; Terumo Europe, Leuven, Belgium, or Cantata 2.5; Cook Medical, Bloomington, Indiana, or Maestro 2.4; Merit Medical Systems, Inc) was used when a more distal catheter tip position was required to avoid reflux of particulate embolic agents during embolization. In all patients, extrabronchial collateral supply was evaluated after selective catheterization of the brachiocephalic trunk and both subclavian arteries with use of a 4-F or 5-F vertebral catheter (Radifocus Optitorque; Terumo Europe); superselective catheterization and embolization of these extrabronchial collaterals was performed with use of 1 of the abovementioned microcatheters resulting in distal occlusion of all bronchial and extrabronchial collaterals identified by angiography. Embolic agents were used at the discretion of the attending interventional radiologist and included 355–500 μm and 500–700 μm polyvinyl alcohol (PVA) microparticles (Contour PVA Embolization Particles; Boston Scientific, Marlborough, Massachusetts) and 500–700 μm and 700–900 μm tris-acryl gelatin microspheres (Embosphere Microspheres; Merit Medical Systems, Inc). When communication between the bronchial or other systemic arterioles and the pulmonary arterioles or venules was suspected on selective angiography, ≥ 355–500 μm PVA microparticles were used. In these particular cases, tris-acryl gelatin microspheres were never used. Microcoils (Target; Boston Scientific, or Tornado; Cook Medical) were used to proximally occlude nonbronchial arteries to avoid nontarget