ORIGINAL ARTICLE

Percutaneous transcatheter vascular embolization for life threatening hemoptysis

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Abstract The aim of this study was to retrospectively evaluate 47 patients (37 males and 10 females, aged 37–72 years) with life threatening hemoptysis treated by bronchial artery embolization. Between April 2007 and April 2012 at the Assuit University Hospital, the cause of hemoptysis was tuberculosis and post TB bronchiectasis in 29 patients, bronchiectasis in 11, 3 arteriovenous malformation, 3 post infective fibrosis and one patient with chronic renal failure. Recurrence of hemoptysis after embolization occurred in 2 patients within the 6 month follow-up period, these cases underwent re-embolization with successful control of hemoptysis. There were no procedure-related major complications. Bronchial artery embolization is a safe and effective palliative treatment for patients with massive hemoptysis.

Introduction

Life threatening hemoptysis is one of the most challenging conditions encountered in critical care and requires a thorough and timely investigation.

Massive hemoptysis has been described as the expectoration of an amount of blood ranging from 100 mL to more than 1000 mL over a period of 24 h, the most widely used criterion is the production of 300–600 mL per day [1–4]. However, depending on the ability of the patient to maintain a patent airway, a life threatening condition may be caused by a rather small amount of hemorrhage. Thus, a more functional defini-
tion of “massive” as an amount sufficient to cause a life threatening condition should be used in deciding whether to undertake interventional management [4,5].

Massive hemoptysis may result from various causes, and the frequency with which these causes occur differs greatly between the Western and the non-Western world. In the non-Western world, pulmonary tuberculosis, including tuberculosis bronchiectasis, is the most common underlying cause of massive hemoptysis. Bronchogenic carcinoma and chronic inflammatory lung diseases due to bronchiectasis, cystic fibrosis, or aspergillosis are the more prevalent causes of hemoptysis in Western countries [1,2,4]. Other causes include lung abscesses, pneumonia, chronic bronchitis, pulmonary interstitial fibrosis, pneumoconiosis, pulmonary artery aneurysm (Rasmussen pneumoconiosis, congenital cardiac or pulmonary vascular anomalies, aortobronchial fistula, ruptured aortic aneurysm, and ruptured bronchial artery aneurysm [6].

Despite advances in medical and intensive care unit management, massive hemoptysis remains a serious threat. According to recently published data, 28% of chest clinicians had experienced patient death from massive hemoptysis during a previous 1-year period [7]. Conservative management of massive hemoptysis carries a mortality rate of 50–100% [1]. The cause of death is usually asphyxiation, not exsanguination [2]. The reported mortality rates for surgery performed for massive hemoptysis range from 7.1% to 18.2% [3]. However, the mortality rate increases significantly, up to about 40%, when the surgery is undertaken as an emergency procedure [3].

Bronchial artery embolization (BAE) has become an established procedure in the management of massive and recurrent hemoptysis; its use was first reported in 1973 by Remy et al. [8]. The efficacy, safety, and utility of BAE in controlling massive hemoptysis have been well documented in many subsequent reports [9–17]. Because of poor pulmonary reserve and other medical comorbid conditions, most patients with massive hemoptysis are not surgical candidates [1,2]. However, surgery remains the procedure of choice in the treatment of massive hemoptysis caused by specific conditions, such as hydatid cyst, thoracic vascular injury, bronchial adenoma, and aspergilloma that is resistant to other therapies [4]. Even in surgical candidates, BAE is effective in preparing the patient for elective rather than high-risk emergency surgery [3].

Methods

During the period between April 2007 and April 2012, 47 patients with life threatening hemoptysis were treated by bronchial artery embolization at the Assuit University Hospital, Assuit, Egypt.

Bronchoscopy findings were taken into consideration whenever they were available. We did not insist on this procedure in order not to delay the treatment. Chest computed tomography was done for those patients without localization of site of bleeding by chest X-ray. Bilateral bronchial angiography was performed in every case.

Angiography was performed via femoral access in all patients. A 5F vascular sheath was used in all cases to facilitate catheter changes. 4F cobra or Simmons-1 catheters were used for selective catheterization. A microcatheter was used when necessary to ensure safe catheterization.

Assessment included selective bronchial angiography in every case. Additional angiography of the intercostal, subclavian or inferior phrenic arteries was performed depending on the location of the disease in the lung. Further flush angiography of the aortic arch and thoracic aorta was performed if the source was not identified. Pulmonary angiography was not routinely performed except in cases with suspected pulmonary arteriovenous malformation.

Extravasation of contrast medium, thrombosis, hypertrophy or tortuosity of the vessels, pseudoaneurysms, parenchymal staining and arteriovenous shunting were considered positive angiographic findings.

After selective catheterization of the bleeding source in the bronchial artery or non-bronchial systemic vessels, embolization was performed under fluoroscopic control using 250–350 μm and 350–500 μm sized polyvinyl alcohol (PVA) particles (Contour; Boston Scientific, Natick, MA) suspended in contrast medium. 350–500 μm PVA particles were used in patients with bronchopulmonary shunts and large bronchial arteries. Embolization was terminated when antegrade flow was observed to stagnate or terminate.

Coils 5/10 mm and 3/4 mm sized (Cook, Bjaeverskov, Denmark) were used to embolize the bleeding source in cases with large arteriovenous malformation. (Fig. 1, shows Large AVM before and after embolization and coilimg).

In patients with recurrent bleeding, additional bronchial artery, aberrant bronchial artery and abnormal non-bronchial systemic and pulmonary supply were investigated with angiography.

Results

The current study included 47 patients with recurrent massive hemoptysis, uncontrolled by medical treatment, 37 (79%) males and 10 (21%) females were included, age range from 37 to 72 years. 8 (17%) current smokers, 18 (38%) ex-smokers and 21 (45%) non smokers were included (Table 1).

Most of patients had hemoptysis due to past pulmonary TB lesions including fibrosis, bronchiectasis and mycetoma (29 patients 62%), also 11(23%) patients with bronchiectasis were included other 7 (15%) cases were 3 patients with arteriovenous malformations, 3 cases with post infective fibrosis and one case with renal failure Fig. 2.

Total of 109 embolization were done ranging (1–5) per patient, including bronchial and non-bronchial systemic arteries. Recurrence of hemoptysis occurred in 2 patients within the 6 month follow-up period, these cases underwent re-embolization with successful control of hemoptysis. There were no major procedure related complications.

Discussion

Severe hemoptysis occurs most commonly in patients with a history of chronic inflammatory pulmonary disease. In the non-Western world, pulmonary tuberculosis – including tuberculous bronchiectasis – is the most common underlying cause in severe hemoptysis [18]. Despite the increase in human immunodeficiency virus (HIV) associated tuberculosis in the West, malignancy, cystic fibrosis and other non-tuberculous causes are still the most frequently reported causes [19]. In this
study group including 47 patients with severe hemoptysis, tuberculosis was the etiology in 69% of cases [20].

CT has diagnostic superiority over bronchoscopy and chest radiograph for demonstrating underlying pathology and the site of bleeding in hemoptysis, especially in bronchiectasis, bronchogenic carcinoma and aspergilloma cases [19]. Vascular pathologies such as arteriovenous malformation or aneurism, which are rare causes of hemoptysis, are also depicted very clearly in contrast enhanced CT examinations [12]. With recent developments in multidetector CT technique it is now possible to scan the whole thorax with very thin slices (1.25 mm) in a very short time (12–15 s) [21,22]. Both the lesion causing hemoptysis and the bronchial and non-bronchial systemic feeding arteries are detected during the same study using 80–100 mL of contrast medium. In angiography controlled studies, 86–87% of the pathologic vessels detected by angiography are reportedly demonstrated with CT angiography (CTA) as well [21,22]. The road map thus prepared for the interventional radiologist by CTA is thought to shorten the examination time in critical patients [23].

The source of severe hemoptysis is the bronchial circulation in 90% of cases [24]. Significant bleeding from the pulmonary circulation is rare (5%) and is usually secondary to erosion of a pulmonary arterial branch by chronic inflammation. It is recommended to investigate the pulmonary circulation for a bleeding source following systemic arterial embolization, in patients with recurring hemoptysis due to fibrocutaneous tuberculosis [25]. In a minority of cases (approximately 5%) severe hemoptysis may originate from the aorta (e.g., aortobronchial fistula, ruptured aortic aneurysm) or non-bronchial systemic pulmonary arteries [26,27]. Intercostal arteries, thoracic arteries originating from axillary and subclavian arteries in the upper and inferior phrenic artery in the lower zone disease should be investigated during the initial session, particularly in cases with chronic infection and pleural disease because non-bronchial systemic artery supply is the most important cause of early recurrent hemorrhage after successful bronchial artery embolization [25].

![Figure 1](image1.png) Large arteriovenous malformation before (A) and after (B) embolization and coiling.

![Table 1](image2.png)

**Table 1** Demographic data and smoking status no (%).

<table>
<thead>
<tr>
<th>Age (mean ± SD)</th>
<th>41 ± 12</th>
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</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>37 (79%)</td>
</tr>
<tr>
<td>Female</td>
<td>10 (21%)</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>8 (17%)</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>18 (38%)</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>21 (45%)</td>
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Figure 2 Etiology of hemoptysis in study patients.
The recent emergence of BAE as a therapeutic modality for life threatening massive hemoptysis has revolutionized management of the disease, as it is a less invasive but reliable procedure that leads to excellent therapeutic outcomes [28,29,7]. Nevertheless, surgical management of massive hemoptysis still plays an important role as a therapeutic strategy.

Since the first report by Remy and colleagues in 1973 [30], the use of BAE for management of life threatening massive hemoptysis has become widespread. Furthermore, developments and application of superselective BAE with a coaxial microcatheter system [31], have accelerated that trend. According to recent outcomes reported by the Mayo Clinic group [32], immediate control of bleeding was reached successfully in 94% of the cases, with 30-day control obtained in 85% of the remaining patients. Also, the Singaporean group [33], working in a region where most hemoptysis cases are related to tuberculosis with pleural abnormalities that may require repeated difficult embolization [34], reported excellent outcomes in patients who underwent BAE, with an overall success rate of 81.6%.

Currently, PVA particles are the most commonly used agents for bronchial artery embolization worldwide. PVA particles are biocompatible and non-biodegradable and are considered to be a permanent embolic agent. However, unpredictable proximal vessel occlusion and catheter blockage caused by clumping or aggregation of irregular-shaped PVA particles have been reported [35]. Recently, the interest in spherical agents has grown, to overcome the drawbacks of PVA. Trisacryl gelatine microsphere (Embosphere; Biosphere, Rockland, MA; Contour SE; Boston Scientific, Boston, MA) is a new embolic agent that is increasingly used for uterine fibroid embolization. In vivo and in vitro studies have shown that these particles clearly have better sizing and penetration characteristics than PVA [36]. Vinaya et al. reported a myocardial infarction followed by stroke in a patient with hemoptysis due to spontaneous passage of particles through the bronchopulmonary shunts with 500 μm sized embospheres [37]. It is obvious that further clinical and experimental studies investigating the effectiveness and safety of bronchial artery embolization with these particles are needed.

Acute control of hemoptysis with endovascular treatment can be achieved in 73–98% of the patients with massive hemoptysis [38–40]. However, hemoptysis can recur with a frequency of up to 20%, especially in cases with chronic tuberculosis, aspergilloma and neoplasia [41–43]. Recurrent bleeding during the first 6 months after the embolization procedure is usually due to undetected bronchial and systemic collaterals caused by diffuse pulmonary disease [25]. Late recurrent bleeding (after 6 months) usually develops due to disease progression. In this study, hemoptysis recurred in 2 cases.

Armand et al., performed BAE in 28 patients with hemoptysis, BAE was technically successful in all patients (bleeding halted within 24 h). Recurrent bleeding occurred in 4 patients with cystic fibrosis (14%) [43].

Cornalba et al., retrospectively studied 534 patients with hemoptysis who underwent BAE. Complete resolution of hemoptysis was achieved within 24 h in 458/477 (96%) cases and within 48 h in 2% of cases [44].

The successful results achieved with endovascular treatment in the control of massive hemoptysis have also brought up the idea of embolization of moderate and chronic recurrent, mild hemoptysis compromising the life quality of the patient. Bar- ben et al. reported the results of bronchial artery embolization in 46 bleeding episodes in 20 patients with cystic fibrosis. There were 22 massive, 10 moderate and 14 chronic recurrent bleeding episodes [41]. They observed that immediate success was achieved in 95% of the cases, whereas recurrent hemoptysis occurred in 55% of the cases after a mean period of 4 months. Yu-Tang et al. reported the success rate as 81.5% in their study group consisting of 103 patients embolized for moderate to massive hemoptysis [42]. They stressed that in 15.5% of cases re-embolization would be necessary and that endovascular treatment should be repeated whenever hemoptysis could be controlled by this method. In this study, hemoptysis recurred in 2 patients within a 6 month after embolization [20].

In summary, effective palliation with endovascular treatment is achieved in the majority of moderate and massive hemoptysis cases after a single intervention. If necessary, the procedure may be repeated as long as the hemoptysis can still be controlled by this method. Endovascular treatment performed by an experienced staff with sufficient technical back-up is an effective and safe choice in the control of primary and recurrent hemoptysis. We believe that bronchial artery embolization should always be considered for treatment of moderate to massive hemoptysis.

References


