

Selective bronchial artery embolization in hemoptysis: A retrospective study

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Abstract

Aim: The aim of this study was to evaluate the efficacy and outcome of BAE in hemoptysis patients. Selective bronchial artery embolization (BAE) is a minimally invasive treatment method developed alternative to surgery for acute recurrent hemoptysis.

Material and Methods: The data of patients who underwent BAE with hemoptysis was collected retrospectively. The etiology of hemoptysis, localization and type of lesion, embolizing agent used and postoperative complications were recorded. Lesions were classified as pathological hypervascularity, arteriovenous fistula (AVF) and extravasation.

Results: A total of 17 patients were included in this study. The most common underlying cause for hemoptysis was tuberculosis (% 40). Embolizing agents used were microspheres in 13 patients, n-BCA iodized oil mixture in 2 patients, polyvinyl alcohol particles in 1 patient and vascular plug in 1 patient. In the first 30 days after the procedures, bleeding completely stopped in 94,2% of the cases. Four patients (1 on 3rd day, 3 in 15-19 months) required re-embolization. Bronchial artery embolization was performed only once in 13 patients (76.4%), twice-in three patients (17.6%) and 3 times in 1 patient (5.8%).

Conclusion: We concluded that BAE is a safe, effective and minimally invasive method that can be performed repeatedly for treatment of hemoptysis.

Keywords: Hemoptysis; bronchial artery embolization; endovascular treatment.

INTRODUCTION

Hemoptysis is a potentially fatal emergency when it causes asphyxia. In patients with hemoptysis, emergency surgery has high morbidity and mortality rates in case of decreased lung capacity due to chronic lung diseases (1,2,3). Surgical treatment options include bronchial artery ligation or lobectomy. They are considered to be the last treatment option because of high mortality rates (4). Bronchial artery embolization (BAE) was developed as an alternative treatment method for hemoptysis by Remy et al., in 1973 (5).

Vascular anatomy of the lungs has a complex structure with many variations. The lungs receive blood flow via both the pulmonary arteries and the bronchial arteries, and vast majority of this flow (98%) is supplied by the pulmonary arteries. Although the bronchial arteries are the main source of hemoptysis, non-bronchial systemic arteries may also be the source of bleeding.

The aim of this study was to evaluate the efficacy and outcome of BAE in patients with hemoptysis.

MATERIAL and METHODS

Medical records of the patients who were referred to our interventional radiology department with the diagnosis of hemoptysis from January 2010 to September 2018 were retrospectively reviewed. This study was approved by the local ethics committee and was carried out in accordance with the ethical standards. Written informed consent was obtained from all patients.

Reasons for hemoptysis, sites of bleeding, pathological vascular findings in digital subtraction angiography (DSA), number of the embolizations, embolizing agents that are used and postoperative complications were investigated. An embolization procedure was assumed as technically successful in case of disappearance of the vascular lesion following embolization. However the other parameters such as complete cessation of the bleeding without supplementary surgical or another interventional procedure and stable hemodynamic status are indicators of clinical success. Re-bleeding or any supplementary intervention

Received: 24.09.2019 **Accepted:** 22.10.2019 **Available online:** 05.12.2019

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during the post-operative period were also inquired.

In embolization procedures, target arteries were selectively catheterized using 5 Fr Simmons-1 /-2 diagnostic catheters (Terumo, Tokyo, Japan) or 4 Fr Cobra shaped catheter (Cook, Bloomington, IN) following a non-selective aortogram. A 3 Fr micro catheter (Renegade, Boston Scientific, USA) was used in order to catheterize target vessel and to perform embolization. All embolization procedures were performed under fluoroscopic guidance to prevent non-target embolization. The procedure was terminated when the pathological vascularity disappeared.

Results for the quantitative variables are shown as means and standard deviations, and the results for the categorical variables are shown in terms of frequencies and percentages. The pre-embolization hemoglobin and hematocrit levels were compared with post-embolization levels (7-10 days) for statistical significance using paired-samples t test. P-values smaller than, or equal to, 0.05 was considered to indicate statistical significance.

RESULTS

Twenty patients (6 females, 14 males, mean age; 56.1 years) who underwent DSA due to hemoptysis were included in this study. In 3 patients, any lesion could not be detected by DSA, therefore no embolization was needed. Reasons for hemoptysis were tuberculosis (n=8), bronchiectasis (n=4), lung cancer (n=2), aspergilloma (n=3) and pseudosequestration (n=2). In one patient, the cause of bleeding could not be found (Table 1).

Table 1. Clinical characteristics of patients with hemoptysis

Characteristics	Value
Patients, n	20
Age (years)	56.1±18.3(15-89)
Male, n (%)	14 (70)
Etiology (n=20)	
Tuberculosis, n (%)	8
Bronchiectasis	4
Aspergilloma	3
Lung cancer	2
Pseudosequestration	2
Idiopathic	1

The target vessel for embolization was the right bronchial artery in nine patients, the left bronchial artery in one patient, the internal mammarian artery in two patients, the thyrocervical artery in one patient, the intercostal artery in one patient and an aberrant artery that originates from the aorta in one patient (fig 1). In two patients, a combination of these vessels were embolized. Hypervascular lesion related to bleeding was detected in 13 patients. In three patients, arteriovenous fistula was seen, and in one patient, extravasation accompanying to a hypervascular

lesion was discovered. Bronchial artery embolization was performed only once in 13 patients (76.4%), twice in 3 patients (17.6%) and three times in 1 patient (5.8%) (Table 2). The reason for bleeding was tuberculosis in all patients who require multiple embolizations. In two patients, more than one arterial branch was embolized in the same session, as the hypervascular lesions were receiving blood flow via two separate feeding arteries.

Table 2. Angiographic characteristics and embolization agents in patients undergoing bronchial artery embolization for hemoptysis

Characteristics	Value
Localization (n=17)	
Right bronchial artery, n (%)	9 (52.9)
Left bronchial artery, n (%)	1 (5.8)
Internal mammarian artery, n (%)	2 (11.7)
Thyrocervical artery, n (%)	1 (5.8)
Intercostal artery, n (%)	1 (5.8)
Aberrant artery, n (%)	1 (5.8)
Combination, n (%)	2 (11.7)
Lesions (n=17)	
Hypervascular lesion, n (%)	13 (76.4)
Hypervascular lesion + Arteriovenous Fistula, n (%)	3 (17.6)
Hypervascular lesion + Extravasation, n (%)	1 (5.8)
Embolization agents (n=17)	
Microspheric embolizing agent, n (%)	13 (76.4)
n-BCA, n (%)	2 (11.7)
PVA, n (%)	1 (5.8)
Amplatzer vascular plug, n (%)	1 (5.8)
Successfull treatment frequency (n=17)	
Once, n (%)	13 (76.4)
Twice, n (%)	3 (17.6)
Thrice, n (%)	1 (5.8)

In 13 patients, microspheric embolizing agent (Embosphere Microspheres, BioSphere Medical, Rockland, MA, USA) 500-700 micron and 700-900 micron in size, were used. In two patients, 1:5 n-butyl cyanoacrylate (n-BCA) / iodinated oil mixture (Histoacryl, B. Braun, Melsungen, Germany; Lipiodol Ultrafluid, Guerbet, Aulnay-sous-Bois, France) was injected (fig 2). Polyvinyl alcohol particules (PVA), 300-500 micron (Contour; Boston Scientific, Cork, Ireland) and 500-700 micron (Contour SE, Boston Scientific, Nattick, MA, USA; Bead Block, Biocompatibles, Farnham, UK) in size, were preferred in one patient. Finally, in one patient, Amplatzer vascular plug (St. Jude Medical, Inc.; Minnesota, USA) was used as the embolizing agent.

In the first 30 days following the procedures, bleeding completely stopped in 94.2% (n=16) of the cases, whereas

one patient underwent a second embolization due to bleeding on the third day. Three patients required re-embolization secondary to recurrent hemoptysis in the 15-19 months interval. The most common complaint due to the procedures was chest pain in 35.2% of the patients (n = 6), but symptomatic medication was sufficient to resolve the pain. No procedure-related complications occurred during follow-up in the other patients.

DISCUSSION

The bronchial arteries are responsible for hemoptysis in 90% of the cases, while non-bronchial systemic arteries may be the source of bleeding in the remaining group (6). Although several variations, there are most commonly two main bronchial arteries, usually one at the right and two at the left. Aberrant bronchial arteries originating from the subclavian arteries, the coronary arteries, the phrenic

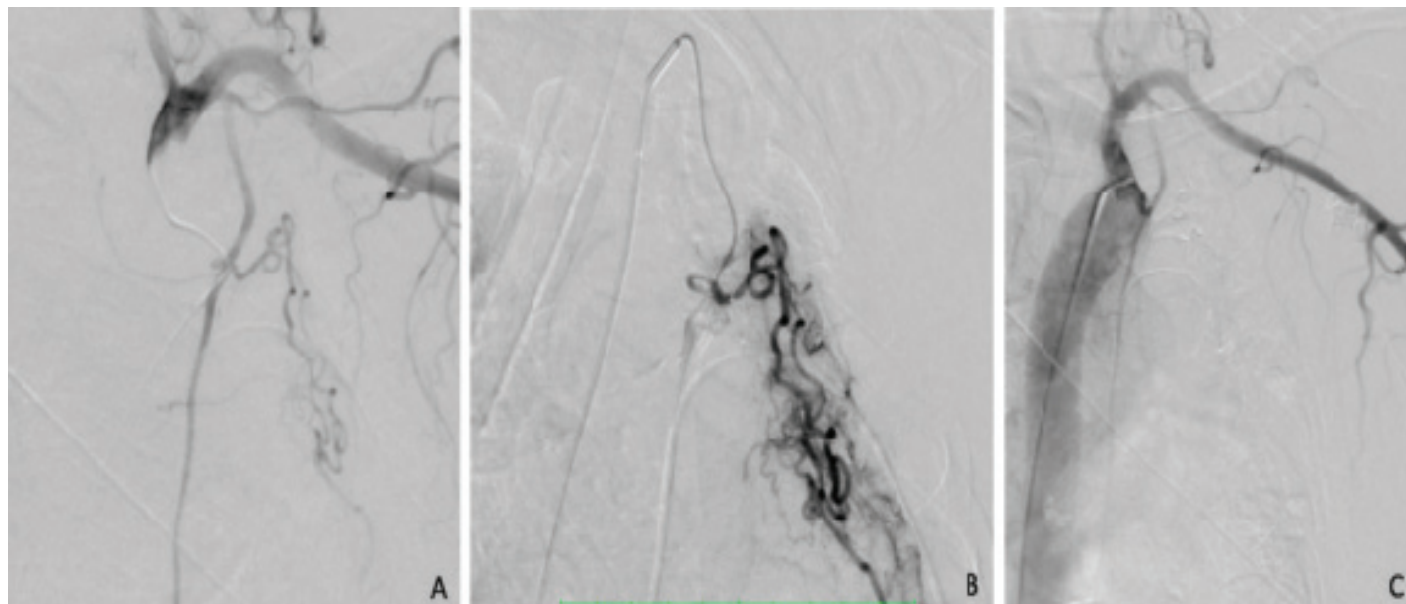


Figure 1. 65-year-old woman with history of tuberculosis presenting with acute hemoptysis treated with bronchial artery embolization. (A) Digital subtraction angiogram (DSA) demonstrates a dilated and tortuous left bronchial artery arising from the left internal mammary artery. (B) Super selective DSA with microcatheter better shows dilation and tortuosity of the bronchial artery branches. There is no active extravasation seen. Embolization was performed with microsphere at this level. (C) Third angiogram shows occluded left bronchial artery.

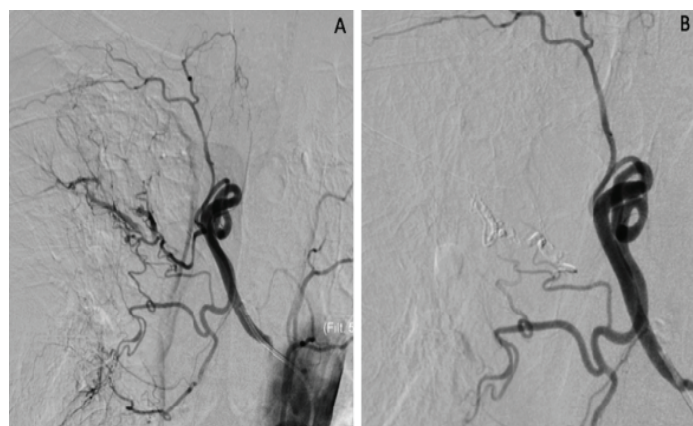


Figure 2. 61-year-old man with history of bronchiectasis presenting with acute hemoptysis treated with bronchial artery embolization. (A) Digital subtraction angiogram (DSA) demonstrates a dilated and tortuous right bronchial artery. (B) After embolization with n-BCA angiogram shows occluded right bronchial artery.

arteries and the thoracoabdominal aorta have been reported in 8.3 to 35 percent of the cases (1, 6, 7). In our study, the bronchial arteries were the common source of hemoptysis, however non-bronchial systemic arteries accounted for bleeding in 41.1% of the patients.

Although hemoptysis is mostly secondary to chronic infectious diseases such as tuberculosis and aspergillosis, it may also occur due to chronic lung diseases such as bronchiectasis and cystic fibrosis, or due to vasculitis, malignancies, pulmonary arteriovenous malformations and iatrogenic reasons such as trauma and catheter placement (8, 9). While malignancy and cystic fibrosis are the most common cause in the Western countries, tuberculosis is the most common cause of massive hemoptysis in our country (10). Infectious and chronic diseases cause hemoptysis by triggering neovascularization that has a fragile structure, as well as leading inflammation and destruction in the lung parenchyma and adjacent artery wall (11-14). In the literature, there is an interesting case of hemoptysis due to pseudo sequestration that receive blood via an aberrant artery originating from the thoracic aorta. The case who has no other vascular abnormality including the bronchial arteries and pulmonary veins has been endovascularly treated by coil embolization of the aberrant artery (15). In our study, the most common reason for hemoptysis was tuberculosis like the previous reports. Bronchiectasis was found to be the most common reason except chronic infectious diseases.

Absorbable gelatin sponges, polyvinyl alcohol particles, microspheric embolizing agents, n-BCA, vascular plugs and coils are the embolic agents are used in BAE (16,17). Absorbable gelatin sponges (Gelfoam®, Pharmacia & Upjohn, Kalamazoo, MI) are not preferred because of their temporary embolizing effects. One of the commonly used embolic agent is PVA particles, which are water-soluble synthetic polymers. Blockage in the catheter due to accumulation of the particles and proximal embolization are disadvantages of PVA. Since arteriovenous shunts in the lungs are approximately 300 µm in size, larger particles should be used in BAE of such disorders (6). Microspheric particles tend to accumulate less in a catheter thanks to its uniform structure compared to PVA. For a safe embolization, microspheric particles should be comparatively larger than PVA particles (18). n-BCA is a tissue adhesive that has been used in the recent years to stop bleeding, and its most important disadvantages are tissue necrosis and non-target embolization (19, 20). In their study comparing the embolizing effect of n-BCA and PVA, Woo et al. (21) reported that n-BCA provided a more permanent embolization and a longer survival. Moreover, no significant difference was found between the two agents when side effects were compared. The most important disadvantage of the coils that provide permanent embolization is that they prevent the treatment of recurrent hemoptysis because of proximal occlusion. Coils are usually preferred in the treatment of the bronchial or pulmonary arteries-related aneurysms and arteriovenous malformations. Miyano et al. (22) reported that coils were appropriate and safe material for embolization in their study of a wide range of cases in which all patients were embolized with coil. In the article, it is stated that the most important point is to try to deploy the coils at the most distal point in the target artery in order not to lose the chance of embolization in recurrent hemoptysis. In our series, similar to the literature, the most commonly preferred embolizing agent was microspheres, and coil embolization was not performed in any procedure.

The success rate of BAE in the early period is high, whereas it has a relatively lower success rate in the long-term. According to several reports, the success rate of BAE was 73-98% in the early period (30 days), and 10-52% in the long term (1-46 months) (6, 23, 24). The reason for recurrence in the early period may be incomplete embolization due to non-bronchial systemic arteries that are missed, while recanalization of the embolized vessel, neovascularization or progression of the underlying disease may be the reasons in the late period. Recurrent bleeding is common in hemoptysis due to chronic tuberculosis, aspergilloma, mycetoma and tumors, and BAE may not be successful unless the underlying disease is treated. (25,26). Neoangiogenesis and destructive effect of the tumor tissue in hemoptysis due to malignancy significantly restrict success of BAE (2,27,28). In our study, it was found that bleeding stopped in 94.2% of the cases in the early period. Re-bleeding rate was 5.8% in the early period, and 5% in the late period. In one patient, who underwent embolization with microspheric particles,

re-bleeding occurred on the 3rd day, and the reason for recurrence was attributed to a second feeding aberrant artery originating from the thyroservical trunk, which was overlooked during the first embolization. In other cases with recurrence, the cause of bleeding may be inadequate treatment of underlying tuberculosis or new collateral formation.

The most common complications of BAE are transient chest pain and dysphagia (29). Bronchial wall necrosis, bronchopleural fistula and unilateral diaphragmatic paralysis are the rare complications (30). Non-target embolization due to the anastomoses or reflux of the embolizing agent may cause complications such as cerebral infarction, ischemic colitis or renal infarction during the embolization of non-bronchial systemic arteries. The most frightening complication is ischemic or chemotactic myelitis, which may result in paraplegia. Since transverse myelitis is caused by anterior spinal artery embolization, it is important to examine the diagnostic angiography, carefully. In the presence of the anterior spinal artery, care must be taken in order to perform a slow injection without reflux by advancing the microcatheter distal to the orifice of the artery (1,13,31). In our series, the most common complication encountered was chest pain, which occurred in 35.2% of the patients, and, it resolved with symptomatic treatment. Other serious complications were not encountered in any of the patients. We believe that a detailed evaluation of the spinal arterial anatomy and an embolization as super selective as possible will increase success rates, and decrease complication rates.

The relatively low number of cases and the disorganized follow-up period are the main limitations of this study.

CONCLUSION

Bronchial artery embolization is a safe, effective and minimally invasive method for the treatment of hemoptysis. It is important that interventional radiologists have sufficient knowledge and experience about the vascular anatomy, embolizing agents and embolization techniques in order to avoid serious complications that may occur.

Competing interests: The authors declare that they have no competing interest.

Financial Disclosure: There are no financial supports.

Ethical approval: Medical records of the patients who were referred to our interventional radiology department with the diagnosis of hemoptysis from January 2010 to September 2018 were retrospectively reviewed. This study was approved by the local ethics committee and was carried out in accordance with the ethical standards.

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