ARTICLE ORIGINAL

# Outcomes of bronchial artery embolization for the management of hemoptysis

# Apport de l'embolisation artérielle bronchique pour le traitement de l'hémoptysie

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**RÉSUMÉ**

**Introduction :** L'hémoptysie est un symptôme alarmant qui implique une prise en charge diagnostique et thérapeutique immédiate. L'embolisation artérielle bronchique est actuellement considérée la technique non invasive de choix pour le traitement de l'hémoptysie massive et/ou récidivante.
**Objectif :** Evaluer l'efficacité et l'innocuité de cette technique pour la prise en charge de l'hémoptysie massive et/ou récidivante.
**Méthodes :** il s'agit d'une étude rétrospective ayant intéressé 46 patients hospitalisés dans notre service de pneumologie au CHU Mohamed Taher Maamouri pour hémoptysie et qui ont bénéficié d'une artériographie en vue d'une embolisation artérielle bronchique
**Résultats :** les dilatations de bronches étaient la cause la plus fréquente de l'hémoptysie dans notre étude (32.6%) suivies par la néoplasie pulmonaire primitive ou secondaire (26%) et la tuberculose pulmonaire (8.6%). Une embolisation artérielle bronchique a été effectuée avec succès dans 97.5% des cas avec un tarissement immédiat du saignement obtenu dans 95% des cas. Une récidive de l'hémoptysie a été notée dans 12% des cas. Aucune complication majeure engageant le pronostic vital ou fonctionnel secondaire à l'embolisation n'a été note dans notre étude.
**Conclusions:** Notre étude confirme l'efficacité et l'innocuité de l'embolisation artérielle bronchique pour la prise en charge de l'hémoptysie massive et/ou récidivante.
**Mots clés :** Hémoptysie; traitement, embolisation artérielle bronchique; efficacité, innocuité

**SUMMARY**

**Introduction:** Hemoptysis is an alarming symptom that requires immediate investigation and management. Bronchial artery embolization (BAE) is a minimally invasive procedure that has become the treatment of choice of recurrent and massive hemoptysis.
**Aim:** To assess the efficacy and safety of BAE for management of recurrent and/or massive hemoptysis.
Methods: A retrospective analysis was carried out of the medical records of 46 patients who were hospitalized in our department of pneumology in Mohamed Taher Maamouri hospital for hemoptysis and who underwent bronchial arteriography (BA) for the purpose of transarterial embolization.
**Results:** The most frequent causes of hemoptysis included idiopathic bronchiectasis (32.6%), pulmonary tumors (26%) and tuberculosis (8.6%) Embolization was successfully performed in 97.5% of cases. Immediate cessation of haemoptysis was achieved in 95%. Recurrence of haemoptysis was noted in 12% of cases. No major complication involving the vital or the functional prognosis, related to BAE was noted.
**Conclusions:** Our study confirms the safety and the efficacy of the BAE for management of massive and/or recurrent hemoptysis.
**Keywords:** Hemoptysis; management, Bronchial artery embolization; efficacy; safety

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## INTRODUCTION

Hemoptysis is a frequent manifestation of a wide variety of pulmonary diseases. It represents an alarming event requiring adequate investigation and urgent treatment to stop bleeding and to prevent relapse. Among the multiple therapeutic resources, bronchial artery embolization is currently considered as the noninvasive procedure of choice for the management of massive and recurrent hemoptysis. When performed by an experienced operator with an adequate technical platform, immediate clinical success, defined as cessation of hemorrhage within 24 hours of BAE or within the same admission, may reach 75-98%, although recurrence rate of hemorrhage ranges from 1% to 27% within 1 month of BAE and from 10 to 55% between 1 and 46 months (1).

The purpose of this study is to identify and to characterize patients with hemoptysis who underwent bronchial arteriography for embolization in our centre and to evaluate their short and long-term outcomes.

## METHODS

We retrospectively reviewed medical records of 46 patients admitted for recurrent or massive hemoptysis between January 2008 and June 2019 and for whom BA in the purpose of embolization was indicated.

Severity of hemoptysis was classified, according to the volume of expectorated blood, as following:

1. Massive hemoptysis was defined as coughing more than 200 milliliter of blood once or more than 500 cc in 24 hours.
2. Moderate hemoptysis was defined as coughing from 50 to 200 milliliter of blood in a single day
3. Mild hemoptysis was classified when bleeding do not exceed 50 milliliters in a single day

Non-pulmonary promoting factors for hemoptysis such as antiplatelet drugs medication, oral anticoagulants or coagulation disorders (thrombocytopenia defined by platelet count less than 150000 Elements/mm 3, spontaneous low prothrombin rate (PR) less than 50% or a prolonged activated partial thromboplastin time (aPTT) more than 60 to 80 seconds) were identified. Results of the investigation performed prior to BA to diagnose the underlying cause of bleeding and to locate it were specified.

All BA were performed by an experienced interventional radiologist. It was carried out via the right femoral artery access in all patients under local anesthesia, percutaneously, using the Seldinger technique. Selective catheterization of bronchial and intercostal artery was performed with a 5 French catheter (Cobra, Simmons or DESLER). Super selective catheterization of abnormal arteries using micro catheters was performed wherever possible. Potential abnormality of bronchial and non-bronchial vascularization, embolized arteries, embolic agents used and immediate results of BAE were specified in the medical report of the radiologist.

Technical success of BAE was defined when the operator succeed to cannulate and to embolize all visualized abnormal arteries. Clinical success referred to complete cessation or significant reduction of hemoptysis within 24 hours of BAE or within the same hospitalization. Clinical failure indicated continued or recurrent hemoptysis immediately after BAE requiring medical attention. Recurrence was defined as significant hemoptysis occurring after an initial clinical success.

After BAE, incidence and severity of complications and mortality were assessed. Were qualified of major, complications involving vital or functional patient prognosis.

## RESULTS

The mean age of our patients was 54.8± 16.4 years [30-90years]. Thirty-six patients (78.2%) were male and 31 (67.4%) had a smoking history.

Additional promoting factors for hemoptysis, apart from their underlying lung disease, included: antiplatelet drugs medication (2 patients); oral anticoagulants (2 patients); thrombocytopenia (4 patients) and spontaneous low PR for one patient.

Eight patients had presented acute respiratory failure and hypovolemic choc

BAE was indicated for massive hemoptysis for 11 patients (24%) and for recurrent mild or moderate hemoptysis for 35 patients (76%).

Chest X-ray performed on admission for all patients, showed nonspecific finding for 26 patients and suggested the specific cause of bleeding and for the 20 others (43.4%).

Chest CT scan was performed for all our patients prior to BA and after hemodynamic and respiratory stabilization. It identified the side of bleeding for 17 patients (36.9%). In these cases, it showed localized ground glass opacities (n=11); localized parenchymatous condensation (n=2) and an endobronchial defect hypodensity related to a blood clot (n=4). Chest CT scan diagnosed etiology of bleeding for 32 patients (69.5%). For three patients, it found neither the side nor the cause of bleeding.

Flexible bronchoscopy was performed before BA for 30 patients. It helped to determine the side of bleeding for 16 patients (53.3%), the lobe for 10 patients (33.3%) and the cause of bleeding for 10 cases ((endobronchial tumors n=9; malignant airway stenosis n=1). It was not performed prior to BA for 16 patients because of abundance of hemoptysis for 11 patient and initial hypoxemia for the five others.

Etiologies of hemoptysis in our study were dominated by idiopathic bronchiectasis (n=15, 32.6%) followed by tumor (n=12, 26%) (Primitive lung cancer n=10; pulmonary metastatic tumor n=2). Others causes were tuberculosis (active n=2; sequel n=4), cystic fibrosis (n=1), pulmonary sequestration (n=1), aspergilloma (n=1). No etiology was found for 10 patients (21.7%).

BA was normal for five patients. For the others 41 cases, it revealed vascular abnormalities and/or parenchymatous blush. Four patients had two associated arteriographic abnormalities (Table 1).

Super selective catheterization of abnormal arteries was possible for eighteen patients.

Different embolic agents were used for embolization: the most used was absorbable gelatin sponge (Curaspon ®) for 23 patients and microspheres in three size ranges: 300 to 500 um, 500 to 700 um, 700 to 900 um for 16 patients. Polyvinylalcohol (PVA) particles, was used for 1 patient.

Technical success was achieved for 40 patients. Only one failure in embolization were noted. In fact, the radiologist had identified spinal arteries arising from bronchial arteries for this patient.

Clinical failure was noticed in two cases suffering from bronchiectasis. For them, bleeding persisted after embolization conducting to a second procedure eighteen days later for one case and to a homeostasis surgery for the second.

**Table 1.** Arteriographic findings

| Arteriographic finding | n | % |
|---|---|---|
| Normal | 5 | 11 |
| BA* hypertrophy and dilatation | 23 | 50 |
| Parenchymal hypervascularity | 15 | 32 |
| Parenchymatous blush | 7 | 15 |

*BA=Bronchial artery

No major complication related to embolization was observed. Two patients presented transient chest pain without electrocardiographic modifications and one patient presented self-limited headache.

One patient suffering from acute respiratory failure due to massive hemoptysis died 4 days after embolization and seventeen patients were lost to follow-up. For the others patients, the mean follow-up were 825 days [range 19-3544 days]. Recurrence occurred in 5 patients (12%) (Table 2).

**Table 2.** Clinical and angiographic details of bleeding relapse

| Patient | Time to recurrence | Initial angiography findings | Embolizing agents | Underlying disease |
|---|---|---|---|---|
| 1 | 7 days | **PB | Embosphere 700-900 | Bronchopulmonary cancer |
| 2 | 8 days | **PV | CURASPON® | Tuberculosis sequel |
| 3 | 2 years | *PB | CURASPON® | Cryptogenic hemoptysis |
| 4 | 2 years | PV+PB | CURASPON® | Bronchiectasis |
| 5 | 8 years | PV | CURASPON® | Bronchiectasis |

*Parenchymatous blush **Parenchymal hypervascularity

## DISCUSSION

Our study confirms the efficacy and the safety of BAE to treat hemoptysis. Over the last 50 years, this technique has become the non invasive procedure of choice for the management of recurrent and massive hemoptysis especially in case of no adequate response to medical care (2,3).

Previous definitions of massive hemoptysis relied only on the volume of expectorated blood. However, recent literature tends to abandon this definition for several reasons. First the criterion of abundance is confusing since there are several thresholds of volume of expectored blood proposed in the literature data. Second, approximating the amount of hemoptysis is often imprecise and frequently over- or underestimated. Third, clinical consequence of hemoptysis depend on not only the volume of expectorated blood but also the rate of bleeding, the ability of the patient to clear blood from the airways and the patient's underlying physiological reserve. So, many authors, in the recent literature data, prefer to define "massive hemoptysis" or "life threatening hemoptysis" as the volume of expectorated blood involving the vital prognosis via the airway obstruction, hypotension or blood loss (4,5). According to this definition, we account only nine life- threatening hemoptysis among our studied patients.

An etiological assessment should be undertaken, in front of hemoptysis, immediately after airway and hemodynamic stabilization. Clinical evaluation looks for similar episode, known coagulation disorders, anticoagulant and antiagregant treatment and signs of pulmonary and extra pulmonary diseases. In addition, physical examination should rule out non-pulmonary causes of bleeding such as epistaxis or hematemesis. Biological investigation should include complete blood counts, profile coagulation and liver and kidney function (6).

Chest X-ray should be systematic in the initial evaluation of all patients with hemoptysis as recommended by the American College of Radiology (7). This exploration is inexpensive and easily accessible in almost tertiary care hospital but it has a low sensitivity to diagnose the underlying cause of bleeding and its false-negative rate is as high as 20–40% (3, 6). In our study chest X-ray, systematically performed for all patients, provided information about the etiology of hemoptysis in 43.4% of cases.

Although there are no established recommendations regarding performing systematically chest CT scan and flexible bronchoscopy prior to BAE these tow investigations are widely performed in front of hemoptysis (7,8).

Panda et al. in systemic review of 22 studies on BAE published between 1976 and 2016 , reported that, in eight recent studies, multidetector CT was performed in the 81%-100% of the sample patients and in seven others studies contrast-enhanced CT was performed **(7).**

Multi-slice angio-CT provides a pulmonary vascular map as well as an exhaustive study of the mediastinum and the parenchyma during the same acquisition. In addition, chest CT scan helps to determine the side and the etiology of bleeding with a sensitivity superior to chest X-ray until 70–88.5% and 60-77% respectively in case of massive hemoptysis (5,6). In our study, chest CT scan was more helpful to identify the etiology of bleeding (76.1%) than to locate it (42.8%).

Several authors consider flexible bronchoscopy complementary to the chest CT scan to determinate the cause and the origin of hemoptysis. It helps to identify the anatomic site and the cause of the bleeding, evaluate the feasibility of therapeutic bronchoscopic intervention if required and to collect samples for cytologic, pathologic, and microbiologic purposes (7,9). However, flexible bronchoscopy is less sensitive in comparison with CT scan to diagnose the underlying cause of hemoptysis (48.7% of cases versus 77.3% of cases) (10). Recent Chinese recommendation emphased that the choice of flexible bronchoscopy vs chest CT scan and the timing of these explorations depend on the equipment availability, institutional practice, and patient's clinical status (6). In our local medical center, this endoscopic examination is considered each time the hemodynamic and the respiratory status of the patient allows it. It was performed for 30 patients of our population and helped us to identify the site and the cause of bleeding in 53.3% and 30% of cases respectively.

Etiologies of hemoptysis are numerous. In our population, bronchiectasis, tuberculosis, lung cancer were the most frequent causes of hemoptysis. This finding is similar to literature data and the three causes represent more than 50 % of etiologies of hemoptysis in several studies (5,11). However, despite advancing technology and thorough investigation, the cause of wide proportion of hemoptysis

remains unknown up to 20% (5). This is similar to our results, and cryptogenic hemoptysis accounted for 21.7% of our studied population.

According to literature, BAE is an effective and safe tool to stop bleeding with technical success rate varying from 81%–100% and immediate clinical success varying from 70%–99% depending on studies (7). Similarly in our study, technical success was achieved in 97.5% and medical success in 95% of cases. Complications of this procedure are rare and generally not major. According to the systemic review published by Panda and al, the median incidence of major complication is 0.1% (0%–6.6%). The most feared complication is transient or permanent paraparesis or paraplegia. It occurred in 0.6%-4.4% and it is attributed to inadvertent embolization of spinal arteries arising from bronchial or intercostobronchial arteries. Superselective catheterization is recommended to ensure more distal embolization to avoid this complication (7). No major complication was noted in our study.

Recurrence rate is variable according studies and ranges from to 9.8–57.5% (7). Early recurrences are probably due to incomplete embolization of incriminated vessels while late one are likely explicated by recanalization of previously embellished vessels, revascularization of the collateral circulation or progression of the underlying pulmonary disease (12). According to literature data, the etiology of hemoptysis is the main factor predictive of recurrence. Aspergillomas, reactivation TB, multidrug resistant TB and idiopathic bronchiectasis were associated with a high risk of bleeding recurrence (6,13). Some authors think that the absorbable nature of embolic agent may foster medium and long-term recurrence (14,15). This fact is not supported by Swanson et al who found no association between the embolic agents used and recurrence (16).

There were some limitations to this study; sample size might be insufficient to identify minor factors that could be associated with the recurrence of hemoptysis after BAE, and patients were not randomized into different modalities of treatment for comparison.

## CONCLUSION

Our results confirm that BAE is a safe and effective treatment for severe and recurrent hemoptysis. However, recurrences are possible, especially in case of progressive underlying disease. In that case, another embolization may be proposed due to the high safety of the procedure.

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