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Bronchial Artery Embolisation as a Life-Saving Procedure in Significant Hemoptysis: A Prospective Case Series from a Tertiary Care Interventional Radiology Unit

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Abstract

Background: Hemoptysis is a potentially life-threatening clinical condition characterized by expectoration of blood from the lower respiratory tract. The bronchial arterial system is responsible for the majority of cases, particularly in chronic inflammatory and infectious lung diseases. Bronchial artery embolisation (BAE) has emerged as a minimally invasive, effective therapeutic option for controlling hemoptysis. ***Aim:*** To evaluate the procedural success, safety, and recurrence rates following bronchial artery embolisation in patients presenting with significant hemoptysis. ***Materials and Methods:*** This prospective case series was conducted over a period of 18 months in a tertiary care interventional radiology unit. A total of 14 patients presenting with moderate to massive hemoptysis were included. All patients underwent computed tomography (CT) angiography prior to the procedure to identify the bleeding source. Bronchial artery embolisation was performed using standard techniques. Outcome measures included technical success, clinical success, recurrence, and complications. Statistical analysis was performed using descriptive statistics and Fisher's exact test. ***Results:*** The mean age of patients was 44.8 ± 13.6 years, with a male predominance (64.3%). Tuberculosis was the most common etiology (42.8%), followed by bronchiectasis (28.6%). Technical success was achieved in 100% of cases, while clinical success was observed in 92.8%. Recurrence occurred in 21.4% of patients, with two patients requiring repeat embolisation. A statistically significant association was found between non-bronchial systemic arterial supply and recurrence ($p = 0.041$). Minor complications included chest pain (14.3%) and dysphagia (7.1%), with no major complications reported. ***Conclusion:*** Bronchial artery embolisation is a safe and effective modality for the management of hemoptysis with high technical and clinical success rates. The presence of non-bronchial systemic arterial supply may predict recurrence, highlighting the importance of comprehensive vascular evaluation.

Keywords: Hemoptysis, Bronchial artery embolisation, Interventional radiology, Tuberculosis, Recurrence

INTRODUCTION

Hemoptysis, defined as the expectoration of blood originating from the lower respiratory tract, is a significant clinical condition that ranges in severity from mild blood-streaked sputum to massive, life-threatening hemorrhage.[1] Although its definition varies, massive hemoptysis is widely understood to be the expectoration of more than 200–600 mL of blood in a 24-hour period. If left untreated, this condition is linked to significant death rates. Due to the possibility of hemodynamic instability and airway impairment, the situation requires prompt assessment and treatment.[2]

Because of its high-pressure systemic character, the bronchial arterial circulation accounts for around 90% of hemoptysis instances. On the other hand, a lower percentage of cases are caused by pulmonary arterial hemorrhage.[3] Chronic lung inflammatory and viral disorders frequently cause bronchial artery hypertrophy and tortuosity, which increases the risk of rupture and bleeding. In underdeveloped nations like India, pulmonary TB continues to be the leading cause of hemoptysis, but bronchiectasis, cancer, and fungal infections are also important causes.

Hemoptysis was traditionally treated with cautious medical treatment and surgery. However, particularly in individuals with little pulmonary reserve, surgery is frequently linked to high rates of morbidity and death. Bronchial artery embolization (BAE) has been a first-line therapy option for hemoptysis management throughout the last few decades. BAE, which was first implemented in the 1970s, is the targeted catheterization and blockage of aberrant systemic arteries that feed the bleeding location, both bronchial and non-bronchial.[4]

BAE has a number of benefits, such as quick bleeding control, little invasiveness, and repeatability in the event of recurrence. Procedural planning and the identification of culprit vessels have been greatly enhanced by developments in imaging methods, especially CT angiography.[5] Recurrence is still a problem despite its high success rates and can be caused by non-bronchial systemic arterial supply, partial embolization, or recanalization.

Improving patient outcomes requires an understanding of recurrence factors. Specifically, if non-bronchial systemic arteries—which might originate from internal mammary, subclavian, or intercostal branches—are not sufficiently treated during embolization, they may lead to recurrent or chronic bleeding.[6]

The purpose of this study is to assess the safety and efficacy of bronchial artery embolization in a prospective cohort of patients who present with hemoptysis. Additionally, variables linked to recurrence will be examined, with an emphasis on the impact of non-bronchial systemic arterial supply.

AIM AND OBJECTIVES

Aim

To evaluate the efficacy and safety of bronchial artery embolisation in the management of hemoptysis.

Objectives

1. To determine the technical success rate of BAE
2. To assess clinical success in controlling hemoptysis
3. To evaluate recurrence rates following the procedure
4. To identify complications associated with BAE

To analyze the association between non-bronchial systemic arterial supply and recurrence

MATERIALS AND METHODS

Study Design

This study was designed as a prospective case series aimed at evaluating the efficacy and safety of bronchial artery embolisation (BAE) in patients presenting with clinically significant hemoptysis. A prospective approach was adopted to allow real-time data collection, uniform procedural protocol, and accurate assessment of outcomes.

Study Duration

The study was conducted over a period of 18 months, during which consecutive eligible patients were enrolled and followed up for assessment of immediate and short-term outcomes, including recurrence and complications.

Study Setting

The study was carried out in the Department of Interventional Radiology of a tertiary care center, equipped with advanced imaging facilities including multidetector computed tomography (MDCT) and digital subtraction angiography (DSA). The center routinely manages complex pulmonary and vascular emergencies, ensuring availability of expertise and infrastructure for bronchial artery embolisation.

Study Population

A total of 14 patients presenting with moderate to massive hemoptysis were included in the study. All patients were evaluated clinically and radiologically prior to intervention.

Inclusion Criteria

- Patients aged ≥18 years
- Patients presenting with moderate to massive hemoptysis (clinically significant bleeding requiring intervention)
- Patients who underwent bronchial artery embolisation
- Patients providing informed consent for the procedure

Exclusion Criteria

- Patients with mild or self-limiting hemoptysis
- Patients who were hemodynamically unstable and unsuitable for intervention
- Patients with uncorrected coagulopathy
- Patients who refused consent

Pre-Procedural Evaluation

All patients underwent:

- Detailed clinical assessment
- Laboratory investigations
- CT angiography to identify bleeding source

Procedure

Bronchial artery embolisation was performed under fluoroscopic guidance. Selective catheterisation of bronchial arteries was achieved using standard microcatheter techniques. Embolic agents like PVA particles (255-355 micrometer) and Abgel were used to occlude abnormal vessels. Care was taken to identify non-bronchial systemic arterial supply.

Outcome Measures

- **Technical success:** Successful catheterisation and embolisation
- **Clinical success:** cessation of hemoptysis within 24 hours post-procedure
- **Recurrence:** Reappearance of hemoptysis after initial control
- **Complications:** Classified as minor or major

Statistical Analysis

Data were analyzed using descriptive statistics. Fisher's exact test was applied to assess association between non-bronchial systemic arterial supply and recurrence. A p-value <0.05 was considered statistically significant.

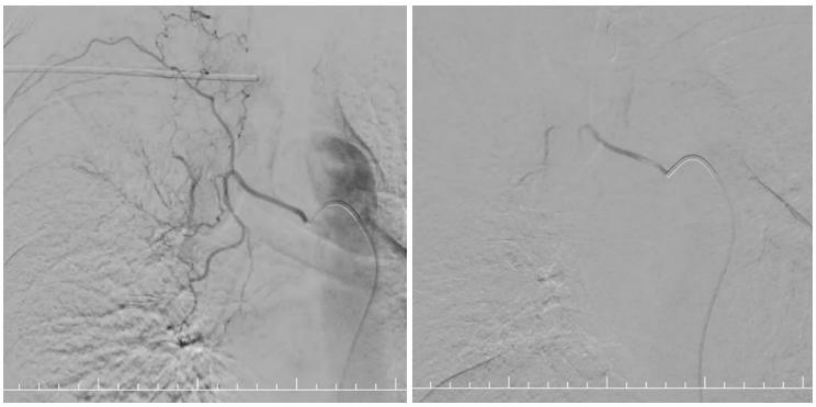

Figure 1

On bronchial artery angiography in a patient with massive hemoptysis shows (left image) tortuous right bronchial artery with dense parenchymal blush and high flow vascularity in right middle and upper zone of lung from right bronchial artery. Post embolization (right image) check angiography shows no abnormal vascular blush suggestive of successful embolisation of culprit bronchial artery.

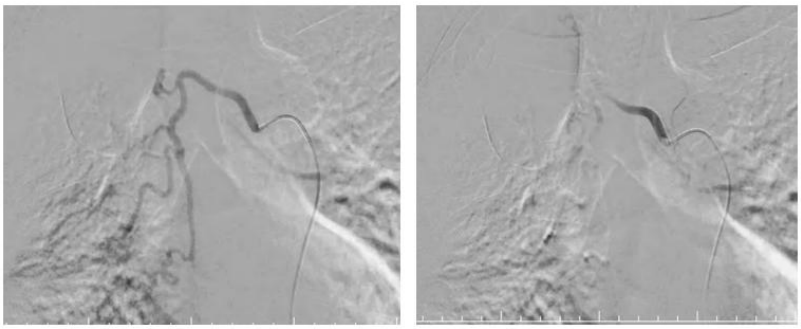

Figure 2

Selective right bronchial artery angiography (left image) demonstrates a markedly tortuous bronchial artery with prominent parenchymal blush and increased vascularity involving the right upper and middle lung zones, consistent with active bleeding from hypertrophied bronchial circulation.

Post-embolization angiography (right image) shows complete resolution of the abnormal vascular blush with absence of abnormal parenchymal staining, indicating successful embolization of the culprit bronchial artery.

RESULTS

Table 1: Demographic Characteristics

Parameter	Value
Mean Age	44.8 ± 13.6 years
Male	9 (64.3%)
Female	5 (35.7%)

The study included a total of 14 patients with a mean age of **44.8 ± 13.6 years**, indicating that hemoptysis predominantly affected middle-aged individuals. There was a **male predominance**, with 9 patients (64.3%) being male and 5 patients (35.7%) female. This suggests a higher incidence of significant hemoptysis among males in the studied population.

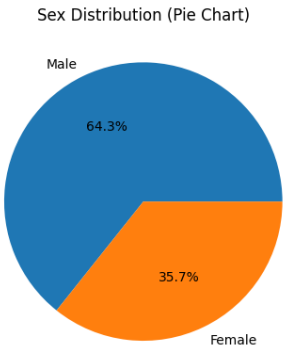

Figure 1: Gender Distribution of Study Participants

Table 2: Etiology of Hemoptysis

Etiology	n (%)
Tuberculosis	6 (42.8%)
Bronchiectasis	4 (28.6%)
Malignancy	2 (14.3%)
Fungal	1 (7.1%)
Others	1 (7.1%)

The most common underlying cause of hemoptysis was **tuberculosis**, accounting for 6 cases (42.8%), followed by **bronchiectasis** in 4 patients (28.6%). **Malignancy** was identified in 2 patients (14.3%), while **fungal infection** and **other causes** contributed to 1 case each (7.1%). These findings highlight infectious etiologies, particularly tuberculosis, as the leading cause of hemoptysis in this cohort.

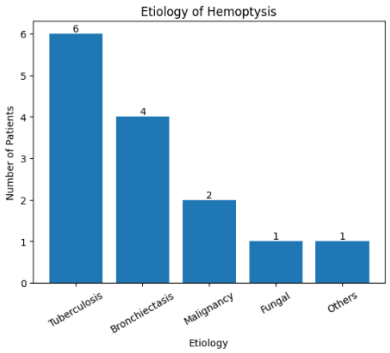

Figure 2: Etiology of Hemoptysis

Table 3: Procedural Outcomes

Outcome	n (%)
Technical success	14 (100%)
Clinical success	13 (92.8%)
Recurrence	3 (21.4%)
Repeat embolisation	2 (14.3%)

Technical success was achieved in **all 14 patients (100%)**, indicating successful catheterisation and embolisation in every case. **Clinical success**, defined as cessation of hemoptysis, was observed in 13 patients (92.8%). **Recurrence of hemoptysis** occurred in 3 patients (21.4%), among whom 2 patients (14.3%) required **repeat embolisation**. These findings demonstrate high effectiveness of bronchial artery embolisation with a relatively low recurrence rate.

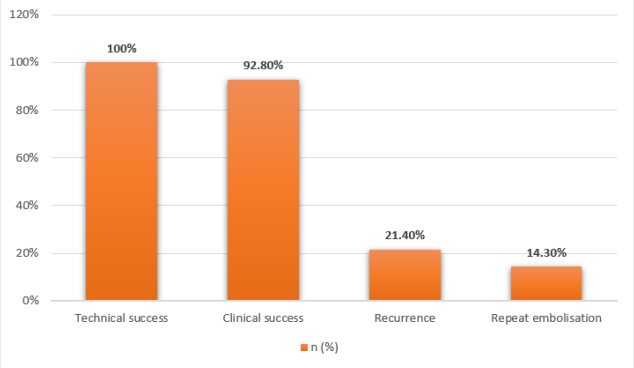

Figure 3

Table 4: Complications

Complication	n (%)
Chest pain	2 (14.3%)
Dysphagia	1 (7.1%)
Major complications	0 (0%)

The procedure was generally well tolerated, with only **minor complications** reported. **Chest pain** was observed in 2 patients (14.3%), and **dysphagia** in 1 patient (7.1%). Importantly, **no major complications** such as spinal cord ischemia or procedure-related mortality were recorded. This underscores the safety profile of bronchial artery embolisation.

Table 5: Association between NBSA and Recurrence

NBSA	Recurrence	No Recurrence
Present	2	1
Absent	1	10

A statistically significant association was found between non-bronchial systemic arterial supply and recurrence ($p = 0.041$). Among patients with **non-bronchial systemic arterial supply (NBSA)**, 2 experienced recurrence while 1 did not. In contrast, among patients without NBSA, only 1 patient had recurrence while 10 remained recurrence-free. Statistical analysis revealed a **significant association between NBSA and recurrence ($p = 0.041$)**. This indicates that the presence of NBSA is an important predictor of recurrent hemoptysis following embolisation.

DISCUSSION

Hemoptysis remains a potentially life-threatening clinical condition that necessitates rapid diagnosis and effective intervention. In the last several decades, bronchial artery embolisation (BAE) has been a mainstay in the treatment of moderate to major hemoptysis, providing a highly successful and minimally invasive substitute for surgical methods, which are frequently linked to increased morbidity and death. [5,7]

A technical success rate of 100% was attained in this investigation, which is similar to previously reported rates of 90% to 100% [8]. Improvements in catheter technology, advances in interventional radiology procedures, and the regular use of pre-procedural CT angiography for accurate identification of bleeding arteries are all responsible for this high success rate [9]. Procedure planning and results are much improved when culprit arteries are accurately identified.

The study's clinical success rate of 92.8% is in line with previous research showing success rates ranging from 85% to 95% [7]. A number of variables, including the degree of underlying lung illness, the existence of substantial collateral circulation, and partial embolization in complicated vascular architecture, might account for the little disparity between technical and clinical success. These results highlight how crucial it is to have a thorough vascular examination before the treatment.

The most frequent cause of hemoptysis in terms of etiology was TB (42.8%), which is consistent with research done in poor nations like India, where pulmonary tuberculosis is still very widespread [10]. Patients with TB are at risk for repeated bleeding episodes due to bronchial artery enlargement and neovascularization caused by chronic inflammatory alterations [1]. Malignancy and bronchiectasis were also

significant contributors, illustrating the wide range of hemoptysis etiologies.

Hemoptysis recurrence after BAE is still a clinically relevant problem. The current study's recurrence rate of 21.4% is within the previously reported range of 10% to 30% [11]. Recanalization of previously treated vessels, partial embolization, or the existence of neglected collateral supply—especially from non-bronchial systemic arteries—can all lead to recurrence.

The statistically significant correlation between non-bronchial systemic arterial supply (NBSA) and recurrence ($p = 0.041$) was one of the study's main conclusions. Recurrent hemoptysis was more common in patients with NBSA, highlighting the importance of careful angiographic assessment and embolization of all contributory arteries [12]. The procedure's long-term effectiveness may be diminished if NBSA is not detected and treated since this might result in ongoing or recurring bleeding.

With relatively modest side effects including dysphagia (7.1%) and chest discomfort (14.3%), all of which were self-limiting, the safety profile of BAE in this research was good. Crucially, no serious side effects, such as spinal cord ischemia, were noted. This is in line with other research showing minimal rates of complications when the operation is carried out by skilled interventional radiologists [7].

In 14.3% of patients, repeat embolization was necessary, demonstrating that BAE is safe, repeatable, and successful in situations of recurrence. Its use as a first-line treatment for hemoptysis is further supported by this. Overall, the results of this study support the notion that bronchial artery embolization is a minimally invasive, safe, and effective therapy option. However, meticulous pre-procedural imaging, cautious patient selection, and complete embolization of both bronchial and non-bronchial artery supply are necessary for the best results.

CONCLUSION

Bronchial artery embolisation is a highly effective and safe minimally invasive procedure for the management of hemoptysis. With few issues, the current study showed great clinical success rates and outstanding technical success. In the population under study, tuberculosis continues to be the most prevalent underlying cause. Recurrence is still a problem despite its efficacy, especially in individuals with non-bronchial systemic arterial supply. To lower recurrence rates, these vessels must be identified and embolized. The procedure's status as a first-line treatment option is further supported by the fact that it may be safely repeated in situations of recurrent hemoptysis. All things considered, bronchial artery embolization provides a dependable, minimally invasive substitute for surgical treatment with good results and low morbidity.

LIMITATIONS OF THE STUDY

This study has several limitations. The small sample size ($n = 14$) restricts the generalizability of the findings and limits statistical strength. Because it was a single-center research, the findings might not apply to other contexts and instead represent institutional practices. Inadequate evaluation of long-term outcomes, such as delayed hemoptysis recurrence, was made possible by the little follow-up period. The research also lacked a control or comparison group and did not evaluate long-term outcomes. These variables may have an impact on how bronchial artery embolization's overall effectiveness and durability are interpreted in more general clinical settings.

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