Transient Headache as a Complication of Bronchial Artery Embolization for Hemoptysis

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Abstract

Background: *Bronchial artery embolization (BAE) is an established treatment for hemoptysis. While major complications are well documented, transient headaches during the procedure are rarely reported.*

Purpose: *To determine the frequency, characteristics, and potential mechanisms of headaches occurring during BAE.*

Methods: *Twenty-six patients (17 male, 9 female; mean age 62.3 ± 13.5 years) undergoing BAE for hemoptysis were prospectively evaluated. All procedures were performed under conscious sedation, using superselective catheterization and polyvinyl alcohol (PVA) particles. Headache onset, duration, location, and relation to procedural stage were recorded. Neurological examination was performed immediately post-procedure. Statistical analysis used Fisher's exact test.*

Results: *Headache occurred in 17 patients (65.3%). Most episodes arose during PVA injection (76.5%, $p < 0.01$) and were unilateral in 58.8%, corresponding to the treated side ($p < 0.05$). All headaches resolved spontaneously after embolization stopped. No patient required analgesics, and no neurological deficits were detected. Headache incidence was unrelated to gender, number of arteries embolized, or underlying cause of hemoptysis.*

Conclusion: *Transient headache is a relatively frequent and benign event during BAE, often associated with PVA injection and lateralizing to the embolized side. Awareness of this phenomenon allows better patient counselling and procedural reassurance.*

Keywords: *Bronchial Artery Embolization (BAE), Headache, PVA Particles.*

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Introduction

Bronchial artery embolization (BAE) has emerged as the preferred method for managing severe hemoptysis, particularly in patients undergoing treatment for malignancies or chronic lung diseases [1, 2]. This technique effectively reduces or halts bleeding by selectively embolizing dilated, hypervascular bronchial arteries with arteriopulmonary shunts or bronchial artery aneurysms using embolic materials such as polyvinyl alcohol (PVA) particles, gelatin sponges, or coils [3, 4]. Although BAE is generally considered a low-risk procedure, complications can occur. One such underreported complication is headache, which, though transient, can cause significant distress to patients [5, 6]. The severity of these headaches varies, but they are typically short-lived and self-resolving, often requiring no specific treatment. The mechanism behind these headaches remains unclear. The purpose of this study was to closely monitor patients for headache onset during BAE, identify any patterns, and investigate potential

causes. Understanding this adverse effect may contribute to improved patient management and procedural comfort.

Materials and Methods

This was a prospective observational study including a total of nine females and seventeen males, aged between 35 and 78 years (mean age: 62.3 ± 13.5 years), who underwent BAE for the management of hemoptysis. The causes of hemoptysis included bronchiectasis, tuberculosis, lung malignancies, and other chronic lung diseases [7, 8]. Two interventional radiologists with more than ten years of experience performed the procedures.

Pre-procedure Preparation and Sedation

All patients underwent pre-angiographic preparation, including routine blood investigations, coagulation tests, and kidney function tests. Patients received intravenous hydration before the procedure. Conscious sedation was administered using midazolam (1-2 mg) and fentanyl (25-50 mcg) to maintain patient comfort while preserving spontaneous respiration [9].

Inclusion Criteria

- Age ≥18 years
- Diagnosis of hemoptysis requiring intervention
- Candidates for BAE based on clinical and radiological criteria (e.g., evidence of hypervascular bronchial arteries, active extravasation on imaging, or recurrent hemoptysis despite medical treatment) [10].

Exclusion Criteria

- Pregnancy
- Inability to provide informed consent
- Severe comorbidities that precluded safe catheterization and embolization procedures, such as severe coagulopathy, end-stage renal failure, or advanced cardiopulmonary disease [11].

Procedure

A baseline chest X-ray, contrast-enhanced CT scan, and bronchoscopy were performed before BAE to identify the source of hemoptysis. Non-bronchial systemic arteries, including esophageal arteries, were evaluated when necessary [12]. An initial diagnostic angiogram was performed using undiluted contrast material (Omnipaque 350 mg I/ml, GE Healthcare, USA) to identify hypertrophied bronchial arteries. A 4-5 Fr Cobra or reverse curve catheter was used for initial catheterization, followed by superselective embolization using a 3 Fr microcatheter [13]. Polyvinyl Alcohol Foam Embolization Particles (300-500 µm, Cook Medical, Bloomington, Indiana, USA) were suspended in a 10 ml mixture of pure contrast (non-diluted) and saline, following the manufacturer's guidelines [14]. Embolization was performed under fluoroscopic guidance, and the presence of collateral circulation was noted to avoid non-target embolization [15] (Figure 1 & 2).

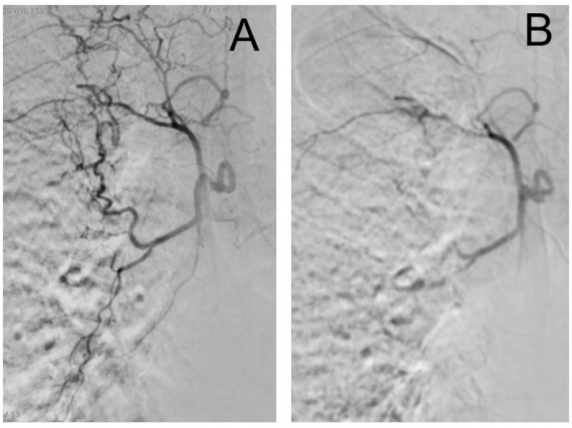

Figure 1: *Selective catheter angiography before (A) and after (B) successful right bronchial artery embolization in a patient with hemoptysis. This patient did not develop any headache.*

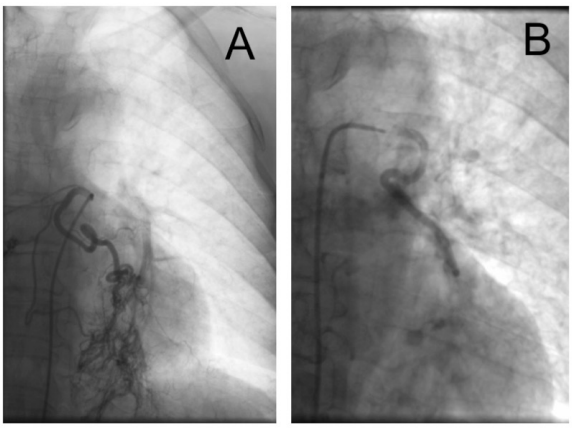

Figure 2: *Selective catheter angiography before (A) and after (B) successful left bronchial artery embolization in a patient with hemoptysis. This patient complained of left sided headache during PVA injection.*

Headache development was recorded based on onset, duration, resolution, lateralization, and the procedural stage at which it occurred. The onset of headaches was monitored relative to PVA or contrast injection, and their duration was tracked from onset to resolution. The resolution time was noted in relation to the cessation of embolization. Lateralization was assessed to determine whether the headache corresponded to the embolized artery, while procedural stage documentation helped differentiate headaches occurring during diagnostic angiography from those induced by embolization. Neurological assessments, including sensory, motor, and reflex examinations, were performed during and imme-

diately after BAE to rule out persistent deficits [16].

Statistical Analysis

Descriptive statistics were used to summarize patient demographics and procedural details. Fisher's exact test was employed to evaluate associations between headache incidence and specific procedural factors. A p-value < 0.05 was considered statistically significant [17].

Results

We included 26 patients in this study, all of whom had undergone bronchial artery embolization. Of these, 17 patients (65.3%) developed headaches during the procedure (Headache-Positive group), while the remaining 9 patients (34.7%) reported no headache (Headache-Negative group).

Gender distribution was almost identical in both groups, with no significant difference (p = 0.93). Across the entire study population, there were 9 female (34.6%) and 17 male (65.4%). Within the headache group, 6 were female (35.3%) and 11 were male (64.7%), a distribution that was very close to that seen in patients without headache (33.3% female, 66.7% male). Altogether, 55 arteries were embolized. Patients in the headache-positive group had 38 arteries treated, while those in the headache-negative group had 17. The relationship between headache occurrence and embolization was statistically significant (p < 0.05) (Table 1).

Characteristic	Total (n = 26)	Headache Positive (n = 17)	Headache Negative (n = 9)	Statistical Analysis
Gender Distribution				
- Female	9 (34.6%)	6 (35.3%)	3 (33.3%)	p = 0.93 (NS)
- Male	17 (65.4%)	11 (64.7%)	6 (66.7%)	p = 0.93 (NS)
Total Arteries Embolized	55	38	17	–
Incidence of Headache	17 (65.3%)	–	–	p < 0.05 (Significant)

Table 1: *Demographic and procedural characteristics of patients undergoing bronchial artery embolization.*

Among those who developed headaches, most (13 patients, 76.5%) reported that the pain started during polyvinyl alcohol (PVA) injection. Four patients (23.5%) experienced headache onset during diagnostic angiography. The link between headaches and PVA injection was statistically significant (p < 0.01), whereas no such significance was found for angiography-related headaches (p = 0.13). In 10 patients (58.8%), the headache was strictly on one side and corresponded exactly to the side of the embolized arteries, which was statistically significant (p < 0.05). Four patients (23.5%) experienced partial lateralization—pain on one side, but not matching all embolized vessels. The remaining 3 patients (17.6%) described a frontal, non-localized headache. These latter patterns did not reach statistical significance (p = 0.13 and p = 0.25, respectively) (Table 2).

Every patient in the headache group experienced a short-lived headache that resolved on its own once the PVA injection was stopped. None required medication. This uniformly transient nature was not statistically significant between subgroups (p = 1.0).

Importantly, no neurological deficits were observed in any patient after the procedure, regardless of whether they experienced a headache (p = 1.0). This supports the overall neurological safety of the procedure.

Discussion

This prospective observational study looked at how often headaches occur during bronchial artery embolization (BAE) and what features they tend to have. We found that nearly two-thirds of patients experienced short-lasting headaches, most often during PVA injection. While usually considered a minor side effect, the frequency we observed suggests it deserves more clinical attention.

The timing of onset—most commonly during the embolic phase—points toward a direct link between the use of PVA particles and headache development. Prior research suggests that these particles may sometimes enter small extracranial or dural vessels through natural or newly formed anastomoses, triggering irritation or activation of pain-sensitive vascular structures [15, 16]. The fact that headaches were less common during diagnostic angiography alone strengthens this connection.

The significant correlation between headache side and the side of arterial embolization in more than half of cases further supports a localized vascular or neurovascular mechanism. Similar

Feature	Headache Positive (n = 17)	Statistical Analysis
Timing of Headache Onset		
– During PVA Injection	13 (76.5%)	p < 0.01 (Significant)
– During Diagnostic Angiography	4 (23.5%)	p = 0.13 (NS)
Headache Lateralization		
– Unilateral (all embolized arteries)	10 (58.8%)	p < 0.05 (Significant)
– Unilateral (partial lateralization)	4 (23.5%)	p = 0.13 (NS)
– Frontal non-lateralized	3 (17.6%)	p = 0.25 (NS)
Duration of Headache		
– Transient (resolved after PVA stopped)	17 (100%)	p = 1.0 (NS)

Table 2: *Characteristics of headache among patients who experienced periprocedural headache following embolization.*

patterns have been seen in other post-BAE neurological symptoms such as facial numbness or vision changes, often linked to overlooked systemic–cranial vascular connections [16, 17]. Despite this, our cohort showed no neurological complications, in line with the established safety profile of BAE when performed carefully [10, 13].

All headaches resolved quickly without treatment once PVA delivery was stopped. This mirrors the findings of Ishikawa et al. and Suzuki et al., who also reported no long-term consequences from these headaches [15, 16].

Interestingly, headache occurrence did not seem to depend on patient gender, the number of arteries treated, or the presence of neurological complications, suggesting it can occur in any patient. However, its strong link to PVA injection indicates a potentially modifiable procedural factor—possibly related to the size or quantity of embolic particles—which could be explored further.

Patients should be informed before the procedure that a brief headache might occur, especially during the embolization phase, so that it does not cause undue alarm. Operators should also pay close attention to vascular anatomy to minimize the risk of non-target embolization, particularly when working with small, freely mobile embolic materials like PVA.

Our study was limited by the relatively small number of participants and the absence of objective pain scoring. We did not examine how particle size, injection duration, or the use of adjunctive agents might influence headache onset or severity. Additionally, we did not use imaging such as CT or MR angiography to check for cranial collaterals, which could have clarified the anatomical basis for side-specific headache.

Conclusion

Transient headache is a relatively frequent but benign event during BAE, often associated with PVA injection and lateralizing to the embolized side. Awareness of this phenomenon allows better patient counselling and procedural reassurance.

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Declarations

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