

ORIGINAL ARTICLE**ROLE OF BRONCHIAL ARTERY EMBOLIZATION IN THE MANAGEMENT OF HEMOPTYSIS****Niranjan Narasimhalu¹, Malay Sarkar², Rajeev Bhardwaj³, Rameshwarsingh Negi⁴, Sunil Sharma⁴****Author's Affiliations:** ¹Post-graduate student; ²Professor and Head; ⁴Assistant Professor, Department of pulmonary medicine, ³Professor, Department of Cardiology, IGMCI, Shimla, India**Correspondence:** Dr. Niranjan Narasimhalu, Email: dr.niranjan21@gmail.com**ABSTRACT**

Objective: The goal of this study was to assess the effectiveness and safety of bronchial (BAE) and/or non-bronchial (NBAE) systemic artery embolization in the management of hemoptysis, and the recurrence of hemoptysis within 3 months after embolization therapy.

Material & Methods: A total of thirty patients who presented with various degrees of hemoptysis (massive, severe, moderate and mild) underwent bronchial artery embolization (BAE) / nonbronchial (NBAE) systemic artery embolization from July 2013 to June 2014. The effectiveness, safety, and the materials used in the embolization procedures were recorded along with short-term relapse.

Results: Most of the patients had severe hemoptysis, reported in 16 (53.3%) cases, nine patients had massive (30%) and 5 (16.7%) patients had moderate hemoptysis. Hemoptysis was caused by tubercular sequelae (except aspergilloma) in 19 patients, active tuberculosis in 7 patients, and aspergilloma and bronchogenic carcinoma in 2 patients each. A total of 70 arteries were embolized in 30 patients including 32 (46%) bronchial and 38 (54%) non-bronchial systemic arteries. The average number of arteries embolized per patient was 2.3. Complete resolution of hemoptysis was achieved within 24 hours in all 30 patients (100%). Rebleeding occurred within 30 days in seven patients. Only one patient had recurrent hemoptysis that occurred 30 days after the procedure. Chest pain was the most common post-embolization complication reported.

Conclusion: Embolization therapy with appropriate technique is a safe and well-tolerated procedure with minor complications. It is important to embolize nonbronchial systemic arteries at the same setting, if they are angiographically shown to be contributing to hemoptysis.

Key words: Bronchial Artery, Embolization, Fibroptic Bronchoscopy, Intercostal Artery, Internal Mammary Artery

INTRODUCTION

Hemoptysis is a common clinical symptom, reportedly responsible for 6.8% of outpatient pulmonary clinic visits, 11% of admissions to a hospital pulmonary service, and 38% referral to a thoracic surgery practice.¹ Pulmonary tuberculosis and its sequelae is an important cause of hemoptysis in developing countries and is the leading cause of hemoptysis in India.² According to the severity of hemoptysis, it is classified as mild (0 to 30 ml), moderate (30 to 100 ml), severe (100 to 600 ml) and massive (>600 ml).³ The

definition of massive hemoptysis varies in the literature. Three criteria are used to define massive hemoptysis based on the magnitude of clinical consequence: hemoptysis that (1) causes death or requires hospitalization, (2) large enough to make clinical or laboratory evidence of systemic blood loss, or (3) requires blood or plasma transfusion (exsanguinating hemoptysis). Most investigators however, use an amount of expectorated blood of 600 mL/24 hour as being massive, because of the observance of impaired oxygen transfer when approximately 400 mL

of blood accumulates in the alveolar space.⁴ The source of massive hemoptysis is usually the bronchial circulation in 90% of the cases and pulmonary circulation in about 5%. In a minority of cases (5%), massive hemoptysis may originate from the aorta (aorto-bronchial fistula, ruptured aortic aneurysm) or the non-bronchial systemic arterial supply to the lungs.⁵ About 80% of the patients with hemoptysis die due to asphyxiation, and remainder due to exsanguinations. Episodes of hemoptysis can be managed by several approaches depending upon the urgency of situation, ranging from medical management to bronchial artery embolization (BAE) and surgery. Since the time of the first description of embolization therapy by Remy *et al*^{6,7} in 1973, it has become the main option for the treatment of massive hemoptysis, either at first presentation or in the case of recurrence. The aim of the study was to determine etiology of hemoptysis and assess the effectiveness and safety of bronchial (BAE) and/or nonbronchial (NBAE) systemic artery embolization for managing hemoptysis, and to study the complications and recurrence of hemoptysis within 3 months after embolization therapy.

MATERIAL AND METHODS

This prospective, observational study was conducted in the department of pulmonary medicine, and Cardiology at Indira Gandhi Medical College, Shimla from July 2013 to June 2014. Total thirty patients admitted in the department of pulmonary medicine, and Cardiology with various degrees of hemoptysis (excluding the cardiac cause of hemoptysis) were evaluated for the effectiveness of embolization therapy. The patients were categorized into mild, moderate, severe and massive depending on the amount of hemoptysis at the time of admission. Every patient was asked to collect the expectorated blood in a glass. The amount of hemoptysis was recorded and converted to a milliliter equivalent (i.e., one small glass = 100 ml). The episodes of hemoptysis were stratified into four groups according to the amount of blood expectorated, i.e., mild (0 to 30 ml), moderate (30 to 100 ml), severe (100 to 600 ml) and massive (>600 ml or any amount in patients who were hemodynamically compromised). Inclusion criteria: All adult patients (>18years) presented various degrees of hemoptysis who did not respond to conservative medical management and required urgent intervention to control bleeding and has signed a

consent form were included in the study. Mild hemoptysis in patients with poor functional reserve was also included. Exclusion criteria: consent not available, contrast allergy, patients with high INR >7 except in patients where it is done as a life saving procedure, and treatable cardiac conditions.

All patients were subjected to detailed clinical history, physical examination and investigations. BAE was done according to the procedure mentioned below.

Procedure: SEMINS ARTIS ZEE CATH LAB SYSTEM

Arterial access was carried out in the supine position using trans-femoral Seldinger technique under local anesthesia. Either 5F or 6F curved JUDKINS RIGHT or COBRA catheter was utilized for catheterization of the bronchial arteries. Search for the bronchial artery opening was made at D4 to D6 levels and if necessary it was extended to the intercostal, diaphragmatic and internal thoracic arteries (non-bronchial systemic arteries were also screened). Contrast medium (ionic or non ionic) 8-12 ml was injected into the bronchial artery at rate of 2 to 3 ml/second. Angiographic signs for locating hemorrhage included: extravasation of the contrast agent, thrombosis of branches of bronchial artery, pathologic hypervascularisation, broncho-pulmonary anastomoses, periarterial diffusion and bronchial artery aneurysms. After identifying the bleeding vessel with the criteria as mentioned above, embolization was performed using either polyvinyl alcohol particles (PVA) of size of 500-700 microns, glue or coils and combinations of any of the materials. The dye was then injected under continuous fluoroscopic guidance, taking care to see that there was no reflux of particles into the aorta. Embolization was termed as complete when 95% of the peripheral branches of the bronchial artery or non-bronchial systemic arteries were occluded and the ante grade flow has stopped. The entire procedure was recorded on a media storage device.

Post-procedure: vitals were monitored for hourly on the day of procedure, then twice daily for next two days. All complications were noted and treated appropriately. Follow up was done 15 days after embolization and subsequently once a month for 3 months during which patients were asked for any recurrence of hemoptysis. If patients were unable to come, follow up was done telephonically.

RESULTS

A total of thirty patients (20 males and 10 females), with an age range of 18–75 years (median, 47.8 years), underwent bronchial (BAE) and/or nonbronchial (NBAE) systemic artery embolization. Among thirty patients 23 (76.66%) patients had history of antitubercular therapy (ATT) in the past (average time since ATT intake was 11 years) and 7 patients (23.33%) had no previous history of ATT intake. Fifteen (50%) patients were non-smokers, 10 patients (33.33%) were current smokers and 5 patients (16.66%) were ex-smokers. Sixteen patients (53.3%) had severe hemoptysis, 9(30%) had massive and 5 (16.7%) patients had moderate hemoptysis. The underlying etiologies of hemoptysis included post-TB sequelae (except aspergilloma) in 19 patients, active tuberculosis in 7 patients, aspergilloma and bronchogenic carcinoma in 2 patients each. Chest radiography was performed in all patients; majority of the patients had post-TB sequelae on chest radiography, 15 (50%) cases. Other diagnoses were bronchiectasis in 4 (13.3%) patients, mass like lesion in 2 (6.66%) patients and aspergilloma in 2 (6.66%) patients. Cavity and consolidation were observed in 3 (10%) and 2 (6.66%) patients respectively and two (6.66%) patients had normal chest radiograph. CT thorax was helpful in elucidating the underlying cause and localizing the site of hemoptysis. CT thorax which was done in 15 (50%) patients revealed the following etiologies: bronchiectasis in 3 (20%) patients, fibrocavitary lesion plus bronchiectasis in 5 (33.33%) patients, aspergilloma in 2 (13.33%) patients, and mass in 2 (13.33%) patients. CT Angiography showed tortorus bronchial arteries in 3 (20%) patients. Fibre-optic bronchoscopy (FOB) was done in five patients only, which showed active bleeding in 4 patients (13.3%) and endobronchial growth in one patient (3.33%). A total of 70 arteries were embolized in 30 patients including bronchial arteries in 32

(46%) and non-bronchial systemic arteries in 38 (54%). The average number of arteries embolized per patient was 2.3. In a total of 32 (46%) bronchial arteries embolized, right bronchial arteries were 18 (56.25%) and left bronchial arteries were 14 (43.75%). The number of non-bronchial systemic arteries embolized was 38 (54%). The embolized systemic arteries included: branches of subclavian artery (n=18), internal mammary artery (n=3), intercostal artery (n=9), subclavian plus internal mammary arteries (n=3), subclavian plus intercostal arteries (n=4), and internal mammary plus intercostal arteries (n=1). Agents used for embolization were polyvinyl alcohol (16 patients), coils (8 patients), gel foam (3 patients), Polyvinyl alcohol plus gel foam (2 patients) and coils plus gel foam in one patient. Three patients (10%) developed no complications, 20 patients (66.6%) had chest pain, 3 patients (10%) had fever, 3 patients (10%) had chest pain and fever, and one patient (3.33%) had local thrombus formation in the right brachial artery. Complete resolution of hemoptysis was achieved within 24 hours in all 30 patients (100%). During the follow up at 1month and at 3 months; eight patients had recurrence of hemoptysis. Seven patients who had recurrence within one month, the underlying etiologies were: Post-TB sequelae in 5 patients (71.4%), bronchogenic carcinoma and aspergilloma in one patient (14.2%) each. Recurrence of hemoptysis occurred after one month in one patient with aspergilloma.

Table 1: Embolization procedure according to arterial site

Arteries Embolized	Number (%)
Bronchial arteries	32 (46)
Non-bronchial systemic arteries	38 (54)
Total	70 (100)

Table 2: Branches of Non- bronchial Systemic Arteries embolized

Non- bronchial Systemic Arteries	N	Materials used				
		PVA	Coils	Gel foam	PVA+gel foam	coils+gel foam
Branches of subclavian artery	18	12	3	1	2	
Internal mammary	3	3				
Intercostal artery	9	7		1		1
Sub clavian and Internal mammary artery	3		2	1		
Sub clavian and Intercostal artery	4	4				
Internal mammary and Intercostal artery	1		1			
Total	38	26	6	3	2	1

Table 3: Distribution of rebleeding according to etiology

Etiology	Rebleeding (n=8)	
	1 month	3 month
Post-TB sequelae	5	
Aspergilloma	1	1
Bronchogenic carcinoma	1	

DISCUSSION

Since its introduction in 1973 by Remy *et al.*⁵ bronchial artery embolization (BAE) has been a well-accepted and widely used procedure in those patients who have massive hemoptysis but unfit for lung resection due to poor lung function, bilateral pulmonary disease or medical comorbidities. It is also indicated in patients with chronic recurrent hemoptysis, mild hemoptysis with poor pulmonary reserve (FEV₁ <35%) and as a bridge for immediate control until definitive measures are undertaken. All the previous studies concluded that embolization therapy is an immediate life saving procedure.^{7, 8,9,10} Embolization therapy was well-tolerated by our patients. An immediate control of bleeding was achieved with embolization in all of our 30 patients (100%). Embolization materials used were: polyvinyl alcohol in 16 patients (53.3%), coils in 8 (26.6%) patients, gel foam in 3 (10%) patients, polyvinyl alcohol plus gel foam in 2 (6.66%) patients and coils plus gel foam in one patient (3.33%). Our results are similar to the study by Baltacioglu *et al.*¹¹ who found embolization with glue successful in controlling hemoptysis immediately in all 25 patients (100%) and in 24 patients (96%) at one month follow-up. Lee *et al.*¹² attempted BAE in 70 patients and the embolization materials used in most patients was polyvinyl alcohol (97%). They reported immediate control of hemoptysis attained following 99% of the procedures. D'Silva *et al.*¹³ in their series achieved complete control of hemoptysis in 90% of 40 patients within 24 hours. In resounding agreement with the aforementioned studies, our study also confirms that BAE with various agents is an effective technique in the management of hemoptysis with high success rates.

In our study a total of 32 (46%) bronchial arteries were embolized [right bronchial arteries embolized were 18 (56.25%) and left bronchial arteries were 14 (43.75%)]. This finding was consistent with the study by Fruchter *et al.*¹⁸ who reported right bronchial artery embolization in 71.2% patients and left bronchial artery embolization in 21.2% patients. Similarly,

D'Silva *et al.*¹³ reported right bronchial artery embolization in 15% patients and left bronchial artery in 12.5% patients. The bronchial artery was the most commonly embolized vessel ($n = 29$) in most of the studies.^{19, 20}. However in our study the predominant source of hemoptysis was from the non bronchial systemic arteries which constituted 54% of the culprit arteries. The total number of non-bronchial systemic arteries embolized in our series was 38 (54%) which included: branches of subclavian artery ($n=18$), internal mammary artery ($n=3$), intercostal artery ($n=9$), subclavian plus internal mammary arteries ($n=3$), subclavian plus intercostal arteries ($n=4$), and internal mammary plus intercostal arteries ($n=1$). Baltacoglu *et al.*¹¹ in their study reported embolization of following 73 non-bronchial systemic arteries: intercostal arteries ($n=6$), internal mammary arteries ($n = 6$), inferior phrenic artery ($n = 2$) and thyrocervical trunk ($n = 3$). In the study by Le *et al.*¹² following non-bronchial systemic arteries were embolized: intercostal arteries (22%), internal mammary arteries (11%). Similarly in their series by Swanson *et al.*¹⁵ the systemic arteries embolized included: the intercostal arteries (45); right internal mammary artery (8); left internal mammary artery (8); inferior phrenic artery (10); lateral thoracic arteries (3); thyrocervical trunk (2); and a left gastric artery (1).

Post-TB sequelae (except aspergilloma) was the leading cause of hemoptysis in our study detected in 19 (63.33%) patients, active tuberculosis was diagnosed in 7(23.33%) patients and the diagnosis of aspergilloma and bronchogenic carcinoma was made in 2 patients (6.66%) each. Prasad *et al.*²¹ in their study observed tuberculosis as the leading cause of hemoptysis seen in 79.2% of patients and the majority of patients had moderate hemoptysis. Nawal *et al.*²² also reported inactive tuberculosis as the most frequent underlying diagnosis of hemoptysis. Therefore, our study is in consistence with the studies from developing countries and in India particularly. The leading cause of hemoptysis still remains the tuberculosis and its sequelae. In our study, fibre-optic bronchoscopy (FOB) was done in 5 patients, four(13.3%) of this showed active bleeding and endobronchial growth was seen in one patient (3.33%). In the study by Eric *et al.*²³ on the utility of FOB before bronchial artery embolization in 27 patients with massive hemoptysis had found that FOB before bronchial artery embolization was unnecessary in patients with hemoptysis of known cause if the site of bleeding can be determined from radiographs and no bron-

choscopic airways management was needed. The complications among our patients were predominantly chest pain in 20 patients (66.6%), 3 patients (10%) had fever, 3 patients (10%) had chest pain and fever, and one patient (3.33%) developed local thrombus. Anuradha *et al.*²⁴ evaluated the results of BAE in 58 patients with post TB sequelae and documented following post-procedure complications: chest pain in 20 (34.5%), dysphagia in 3 (5%), transient dissection of bronchial and intercostal arteries in 2 (3.4%) patients. Fever, contrast reaction and transient ischemic attack (weakness of left upper limb) in one patient each. Thus, chest pain remains the most common post-embolization complication in the present as well as aforementioned study. In our study, during the follow up at 1 month and upto 3 months seven patients had rebleeding within 30 days of post embolization and one patient had recurrent hemoptysis 30 days after the embolization procedure. Seven patients who had recurrence within one month, the underlying etiologies were: post-TB sequelae in 5 patients (71.4%), bronchogenic carcinoma and aspergilloma in one patient (14.2%) each. Recurrence of Hemoptysis which was noted after 1 month in one patient with aspergilloma. Patients with post-TB sequelae had mild hemoptysis and were managed conservatively whereas patients with aspergilloma were advised surgical management. One patient of bronchogenic carcinoma was sent to radiotherapy department for further management. Similarly a study by Racil *et al.*²⁵ reported the short (< 30 days) and medium-term (> 30 days and < 3 years) recurrence rate of hemoptysis was 17.39% and 8.69% respectively after BAE in 53 consecutive patients. The 50% episodes of short-term recurrences were related to aspergilloma and 80% of the patients with aspergilloma had short-term recurrence. The long-term recurrence (>3 years) of hemoptysis was also related to aspergilloma. Singhal *et al.*²⁶ also reported aspergilloma as the cause of recurrence of hemoptysis in one patient during their one year of follow up. Thus aspergilloma remains the commonest cause of recurrence of hemoptysis after embolization and requires repeated embolization or definitive surgical management.

CONCLUSIONS

Embolization therapy is useful to control acute, chronic and recurrent hemoptysis.

It is important to embolize non-bronchial systemic arteries at the same sitting, as more than 50% of culprit arteries are of non-bronchial origin. It is also important to treat the underlying primary pulmonary condition in order to reduce future risk of hemoptysis. Embolization therapy with appropriate technique is a safe and well-tolerated procedure with minor complications and better outcomes than medical, surgical, or bronchoscopic techniques alone. In view of our results, we continue to favor the simplest and the quickest procedure the embolization therapy in controlling hemoptysis.

Limitations: our study had few limitations. It was a short duration study and study population was small. We need large sample and longer study duration. Studies are also needed to determine whether any of the various embolic materials currently available is superior in preventing rebleeding.

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