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Original Research Article

Role of Bronchial Artery Embolization in the Management of Massive Haemoptysis

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Abstract

Background: In this study, we wanted to evaluate the effectiveness and safety of embolization therapy as a lifesaving procedure in haemoptysis patients. Demographic profile and the amount of haemoptysis were noted. Various investigations were done to diagnose the underlying aetiology. Cortical blindness has been reported and it represents as an extremely rare neurological complication. Bronchial artery embolization (BAE) is an effective and safe procedure for the management of haemoptysis.

Materials and Methods: This hospital based prospective study conducted among thirty patients with varying degrees of haemoptysis (excluding cardiac cause of haemoptysis) was done to evaluate the effectiveness and safety of embolization therapy in patients with haemoptysis, admitted in the Department of Pulmonary Medicine, Medicine and Cardiology, Indira Gandhi Medical College, Shimla from July 2013 to June 2014.

Results: Total number of bronchial arteries embolized was 32 (46 %). Out of which, right bronchial arteries were 18 (56.25 %) and left bronchial arteries were 14 (43.75 %). Following embolization materials were used: Polyvinyl alcohol (PVA) in 18 arteries, coils in 9 arteries and gel foam in 3 arteries.

Total 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 intercostals arteries (n = 4), internal mammary plus intercostal arteries (n = 1). Following embolization materials were used: PVA in 26 arteries, coils in 6 arteries and gel foam in 3 arteries.

Conclusion: Embolization therapy is useful to control acute, chronic and recurrent haemoptysis. 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 haemoptysis. Embolization therapy with appropriate technique is a safe and well-tolerated procedure with minor complications and has got better outcomes than medical, surgical, or bronchoscopic techniques alone. In view of our results, we continue to favour the simplest and the quickest procedure, the embolization therapy in controlling haemoptysis.

Keywords: Bronchial Artery Embolization (BAE), Massive Haemoptysis.

Introduction

Haemoptysis is defined as the expectoration of blood from the respiratory tract, [1] a spectrum that varies from blood-streaks in the sputum to coughing up large amounts of frank blood. It may be a symptom of various underlying diseases and needs thorough evaluation. The frequency of each disease as a cause of haemoptysis varies in different series, according to the geographical area. [2] Haemoptysis 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.[3] Pulmonary tuberculosis is an important cause of haemoptysis in developing countries and is the leading cause of haemoptysis in India. [4] According to the severity of haemoptysis, it is classified as mild (0 to 30 ml), moderate (30 to100 ml), severe (100 to 600 ml) and massive (> 600 ml). [5] Three criterias are used to define massive haemoptysis based on the magnitude of clinical consequence: haemoptysis 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 haemoptysis). Most investigators, however, use an amount of expectorated blood of 600 mL/24 hours as being massive, because of the observance of impaired oxygen transfer when approximately 400 mL of blood accumulates in the alveolar space. [6] Majority of the patients with haemoptysis die due to asphyxiation in 80% of the cases, and exsanguinations in the remainder.

The lungs have dual vascular supply including pulmonary and bronchial arteries. The source of massive haemoptysis is usually the bronchial circulation in 90 % of the cases and pulmonary circulation in about 5 %. In a minority of cases (5%), massive haemoptysis may originate from the aorta (aortobronchial fistula, ruptured aortic aneurysm) or the non-bronchial systemic arterial supply to the lungs. [7] In many acute and chronic lung diseases, pulmonary circulation is reduced or occluded at the level of the pulmonary arterioles because of hypoxic vasoconstriction, intravascular thrombosis, or vasculitis. As a result, bronchial arteries proliferate and enlarge to replace the pulmonary circulation. The enlarged bronchial vessels, which exist in an area of active or chronic inflammation, may rupture due to erosion by a bacterial agent, inflammation or due to elevated regional blood pressure. The arterial blood under systemic arterial pressure subsequently extravasates into the respiratory tree, resulting in massive haemoptysis.

Localization of the bleeding site prior to embolization therapy is very important if the procedure is to be performed in a focused and efficient manner. Chest radiographs often aid in the diagnosis. Apart from the ability to suggest specific diagnoses, the radiography helps in localization of bleeding in approximately 60% of cases. [8] However, in 20% to 40% of patients with haemoptysis, the chest radiograph is normal or non-localizing. [9,10]

Computed tomography (CT) is superior to chest radiography, and comparable to bronchoscopy for detecting the site of bleeding in massive haemoptysis. In addition, CT is much more efficient than bronchoscopy to determine the cause of bleeding (60 – 77 vs. 2.5 – 8%). [11,12] Moreover, by showing possible extra-pulmonary causes of haemoptysis, such as false aortic aneurysms, CT scan obviate the need for bronchial arteriography. Thus, CT angiography with high-resolution CT scan should be the primary diagnostic modality if the initial investigation is

inconclusive. In up to 34 % of patients, no cause of haemoptysis can be found after adequate investigation and such cases are termed as having cryptogenic haemoptysis.

Since the time of the first description of embolization therapy by Remy et al. [13,14] in 1973, it has become the main option for treatment of massive haemoptysis, either at first presentation or in the case of recurrence. Prior embolization therapy facilitates surgical treatment and improves the results, as it facilitates scheduled surgery rather than emergency surgery. In addition to massive haemoptysis, lesser degrees of haemoptysis may also require treatment, depending on the patient's underlying pulmonary reserve and ability to maintain a patent airway. Ongoing chronic but non-massive haemoptysis that impairs a patient's quality of life may also require endovascular treatment. Lastly, episodes of milder haemoptysis may be precursor of a life-threatening massive haemoptysis event in the future. In the hands of a skilled interventionist, technical success rates of 90% can be achieved with embolization therapy. [12] Several types of embolic materials have been used for BAE, such as coils, gel foam, poly vinyl alcohol and glue. Chest pain represents the most common adverse event following embolization therapy occurring in 24 – 91% patients and is self-limiting in the vast majority of cases. [15] Transient dysphagia can also occur. Spinal cord ischemia and transverse myelitis are the most feared and recognized complications. They are, fortunately, extremely rare. The use of non-ionic contrast agents has significantly reduced the risk of transverse myelitis. Cortical blindness has been reported and it represents as an extremely rare neurological complication. Therefore, BAE is an effective and safe procedure for the management of haemoptysis. The present study was undertaken to evaluate the efficacy and safety of embolization therapy as a lifesaving procedure in haemoptysis patients.

Aims and Objectives

The aim of this study is to evaluate the effectiveness and safety of embolization therapy as a lifesaving procedure in haemoptysis patients. Demographic profile and the amount of haemoptysis were noted. Various investigations were done to diagnose the underlying aetiology. Cortical blindness has been reported and it represents as an extremely rare neurological complication.

Materials and Methods

This hospital based prospective study conducted among thirty patients with varying degrees of haemoptysis (excluding cardiac cause of haemoptysis) was done to evaluate the effectiveness and safety of embolization therapy in patients with haemoptysis, admitted in the Department of Pulmonary Medicine, Medicine and Cardiology, Indira Gandhi Medical College, Shimla from July 2013 to June 2014.

Result

Table 1

Amount of Haemoptysis	**Frequency**	**%**
Massive	9	30.0%
Severe	16	53.3%
Moderate	5	16.7%
Total	30	100%
Severity of Haemoptysis		

Out of 30 patients, 9 patients (30%) had massive haemoptysis, 16 patients (53.3%) had severe haemoptysis and 5 patients (16.7%) had moderate haemoptysis. Majority of patients (53.3%) had severe haemoptysis in our study.

Table 2

Causes of Haemoptysis	**Total**	**Massive**	**Severe**	**Moderate**	**P value**
		Frequency (%)	**Frequency (%)**	**Frequency (%)**	
Post-TB sequelae	19	6 (66.7%)	11 (68.8%)	2 (40%)	0.095
Active TB	7	0 (0%)	4 (25%)	3 (60%)	
Aspergilloma	2	1 (11.1%)	1 (6.2%)	0 (0%)	
Bronchogenic carcinoma	2	2 (22.2%)	0 (0%)	0 (0%)	
Total	30	9 (100%)	16 (100%)	5 (100%)	
Causes of Haemoptysis					
Smoking Status	**Total**	**Massive**	**Severe**	**Moderate**	**P value**
		Frequency (%)	**Frequency (%)**	**Frequency (%)**	
Never smoker	15	3 (33.3%)	8 (50%)	4 (80%)	0.547
Current smoker	10	4 (44.4%)	5 (31.2%)	1 (20%)	
Ex-smoker	5	2 (22.2%)	3 (18.8%)	0 (0%)	
Total	30	9 (100%)	16 (100%)	5 (100%)	
Smoking Status					

Post-TB sequelae (except aspergilloma) was the most common aetiology observed in 19 (63.33%) patients. Active tuberculosis was diagnosed in seven patients (23.33%). The diagnosis of aspergilloma and bronchogenic carcinoma were made in two patients (6.66%) each.

Post-TB sequelae had been the most frequent diagnosis in massive haemoptysis group and was reported in 6 (66.6%) patients. Two patients (22.2%) had lung cancer, and one (11.1%) patient had aspergilloma. Post-TB sequelae was again the most common aetiology in patients with severe haemoptysis and was reported in 11 (68.8%) patients. 4 patients (25%) had active TB and one patient (6.2%) had aspergilloma. Patients with moderate haemoptysis included 3 patients (60%) with active TB, and 2 patients (40%) with post-TB sequelae.

Table 3

Smoking Index	**Total**
0	**15(50%)**
0 - 500	**9(30%)**
501-1000	**3(10%)**
1001-1500	**3(10%)**
Total	**30(100%)**
Smoking index	
Chest Radiograph	**Total**
Normal	2(6.66%)
Post-TB fibro-cavity disease	15(50%)
Bronchiectasis	4(13.33%)
Aspergilloma	2(6.66%)
Cavity	3(10%)
Mass lesion	2(6.66%)
Consolidation	2(6.66%)

Total	30(100%)
Investigations	
CT Thorax/Angiography	**Total**
Not done	15(50%)
Bronchiectasis	3(20%)
Fibro-cavity lesion and bronchiectasis	5(33.33%)
Aspergilloma	2(13.33%)
Mass lesion	2(13.33%)
Angiography showing tortuous arteries	3(20%)
CT Thorax/Angiography	

Fifteen patients (50%) were never smokers, 10 patients (33.33%) were current smokers, and 5 patients (16.66%) were ex-smoker. Four patients (44.4%) with massive haemoptysis were current smokers, 3 (33.3%) were never smokers and 2 patients (22.2%) were ex-smoker. In those patients with severe haemoptysis, 8 patients (50%) were never smokers, 5 (31.2%) were current smokers, 3 (18.8%) were ex-smoker and in patients with moderate haemoptysis, 4 (80%) were never smokers, and one patient (20%) was a current smoker.

Smoking index is defined as the number of cigarettes or bides smoked per day multiply by the years of smoking. In our study, 15 patients (50%) were non-smokers, 9 patients (30%) had smoking index of 0 to 500, 3 patients (10%) had smoking index of 501 to 1000, and another 3 patients (10%) had smoking index ranging between 1001 to 1500.

Table 4

Bronchial Artery	**Number**	**Materials used**				
		PVA	**Coils**	**Gel Foam**	**PVA Plus Gel Foam**	**Coils Plus Gel Foam**
Right	18	11	5	1		1
Left	14	7	4	2	1	
Total	32	18	9	3	1	1
Bronchial Artery						
Non-bronchial Systemic Arteries	**Number**	**Materials used**				
		PVA	**Coils**	**Gel Foam**	**PVA Plus Gel Foam**	**Coils Plus 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**
Non-bronchial Systemic Arteries						

Chest radiography was done in all patients presenting with haemoptysis. Majority of the patients had post-TB fibrosis changes on chest radiography, noted in 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. Two (6.66%) patients had normal chest radiograph.

CT thorax was done in 15 (50%) patients. Etiological distribution of patients was as follows: bronchiectasis in 3 (20%) patients, fibro-cavitatory lesion plus bronchiectasis in 5 (33.33%) patients, aspergilloma in 2 (13.33%) patients, and mass in 2 (13.33%) patients. CT angiography showed tortuous bronchial arteries 3 (20 %) patients.

Total number of bronchial arteries embolized was 32 (46 %). Out of which, right bronchial arteries were 18 (56.25%) and left bronchial arteries were 14 (43.75%). Following embolization materials were used: PVA in 18 arteries; coils in 9 arteries; gel foam in 3 arteries; PVA plus gel foam in one artery and coils plus gel foam in one artery.

Total 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 intercostals arteries (n = 4); internal mammary plus intercostal arteries (n = 1).

Following embolization materials were used: PVA in 26 arteries; coils in 6 arteries; gel foam in 3 arteries; PVA plus gel foam in 2 arteries; Coils plus gel foam in one artery.

Table 5

Past h/o PTB	**Total**	**Massive**	**Severe**	**Moderate**	**P value**
		Frequency (%)	**Frequency (%)**	**Frequency (%)**	
No	7	2 (22.2%)	3 (18.8%)	2 (40%)	0.616
Yes	23	7 (77.8%)	13 (81.2%)	3 (60%)	
Total	30	9 (100%)	16 (100%)	5 (100%)	
History of Previous ATT intake					

In this study, 23 (76.66%) patients had taken anti-tubercular 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. Among those patients with massive haemoptysis, 7 (77.8%) had a past history of pulmonary tuberculosis, 2 (22.2%) had no history of pulmonary tuberculosis. Thirteen (81.2%) patients with severe haemoptysis had a past history of pulmonary tuberculosis, and 3 (18.8%) had no history of pulmonary tuberculosis whereas in patients with moderate haemoptysis, 3 (60%) patients had a past history of pulmonary tuberculosis and 2 (40%) had no history of pulmonary tuberculosis.

Table 6

Aetiology	Re-bleeding	
	1 Month	3 Month
Post-TB sequelae	5	
Aspergilloma	1	1
Bronchogenic carcinoma	1	
Total	8	
Recurrence of Haemoptysis.		
Materials Used for Embolization	Re-bleeding	
	1 Month	3 Month

PVA	5	
Coils	1	
PVA plus gel foam		1
Coils plus gel foam	1	
Embolization Materials Used		

During the follow up at 1 month and at 3 months, eight patients had recurrence of haemoptysis. In seven patients who had recurrence within one month, the underlying aetiologies were: Post-TB sequelae in 5 patients (71.4%), bronchogenic carcinoma and aspergilloma in one patient (14.2%) each. Recurrence of haemoptysis occurred between 1 to 3 months in one patient of aspergilloma. Patients with post-TB sequelae had mild haemoptysis 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. There was no mortality during the study period.

The embolization materials used in patients who had recurrence within one month included: PVA in 5 patients (71.4%), coils in one patient (14.2%) and coils plus gel foam in one patient (14.2%). Only one patient who was embolized with PVA plus gel foam had recurrence between 1 to 3 months.

Discussion

Haemoptysis is the expectoration of blood from the respiratory tract and is the presenting symptom in many clinical entities. The overall goals of management of the patient with haemoptysis are threefold: bleeding cessation, aspiration prevention, and treatment of the underlying cause. In the present study, patients were categorized into mild, moderate, severe and massive depending on the amount of haemoptysis at the time of admission. Every patient was asked to collect the expectorated blood in a glass. The amount of haemoptysis was recorded and converted to a millilitre equivalent (i.e., one small glass = 100 ml). The episodes of haemoptysis were stratified into four groups according to the amount of blood expectorated, i.e., mild (0 to 30 ml), moderate (30 to100 ml), severe (100 to 600 ml) and massive (> 600 ml or any amount in patients who were hemodynamically compromised). Majority of the patients in our study had severe haemoptysis. Sixteen patients (53.3%) had severe haemoptysis, 9 (30%) had massive and 5 (16.7%) patients had moderate haemoptysis. However, there is no universally accepted definition of quantifying the episodes of haemoptysis.

Lundgren et al. [16] in a study of 50 patients, attempted to quantify haemoptysis into mild, moderate or massive depending on the amount of blood expectorated as follows: < 100 mL in 24 h (mild); 100 - 600 mL in 24 h (moderate); and > 600 mL in 24 h or > 30 mL/h massive.

The mean age of the patients was 47.8 years. The 36 - 55 years' age group contained the largest number of 16 patients (53.3%).

Post-TB sequelae (except aspergilloma) was the leading cause of haemoptysis in our study and was detected in 19 (63.33%) patients. Active tuberculosis was diagnosed in 7 (23.33%) patients. The diagnosis of aspergilloma and bronchogenic carcinoma were made in 2 patients (6.66%) each. Post-TB sequelae had been the most frequently diagnosed condition in massive haemoptysis and was reported in 6 (66.6%) patients. Two patients (22.2%) had lung cancer and one (11.1%) patient had aspergilloma. In patients with severe haemoptysis, post-TB sequelae, active TB and aspergilloma was detected in 11 (68.8%), 4 (25%) and one patient (6.2%) respectively. Patients with

moderate haemoptysis included 3 (60%) patients with active TB and 2 (40%) patients with post-TB sequelae.

Abalet al. [17] in their study of 52 patients reported bronchiectasis (21.2%) as the most common aetiology of haemoptysis. Other causes were old pulmonary TB (17.3%), active pulmonary TB (15.4%), carcinoma (9.6%), bronchitis (5.8%), aspergilloma (1.9%), rheumatic heart disease (1.9%), carcinoid tumour (1.9%), and unknown cause (25%).

In our study, 23 (76.66%) patients had taken anti-tubercular therapy in the past (average time since ATT intake was 11 years) and 7 patients (23.33%) had no previous history of ATT intake. Among those patients with massive haemoptysis, 7 (77.8%) patients had a past history of pulmonary tuberculosis, 2 (22.2%) had no history of pulmonary tuberculosis. Thirteen (81.2%) patients with severe haemoptysis had a past history of pulmonary tuberculosis and 3 (18.8%) patients had no history of pulmonary tuberculosis whereas in patients with moderate haemoptysis, 3 (60%) patients had a past history of pulmonary tuberculosis, and 2 (40%) patients had no history of pulmonary tuberculosis. Haemoptysis is therefore more common in patients with a past history of tuberculosis.

In our study, 15 (50%) patients were non-smokers, 10 patients (33.33%) were current smokers and 5 patients (16.66%) were ex-smokers. Among patients with massive haemoptysis, 4 (44.4%) were current smokers, 3 (33.3%) were non-smokers and 2 patients (22.2%) were ex-smokers. In those patients with severe haemoptysis, 8 patients (50%) were non-smokers, 5 (31.2%) were current smokers, 3 (18.8%) were ex-smokers and in patients with moderate haemoptysis 4 (80%) were non-smokers and one patient (20%) was a current smoker. These findings were consistent with another study from Greece carried out in 184 patients presenting with haemoptysis, in which 145 were smokers, 39 were non-smokers. [18] Bronchiectasis was more frequently detected in non-smokers with moderate/severe haemoptysis and/or a history of TB, whereas lung cancer was more frequently detected in smokers. Smoking is also considered as an important risk factor in the development of haemoptysis. Fruchter et al. [19] reported right bronchial artery embolization in 71.2% patients and left bronchial artery embolization in 21.2% patients. In a study by D'Silva et al. [20] the right bronchial artery was embolized 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.

In our study, 8 patients had recurrence of haemoptysis during the follow up at 1 month and at 3 months. Seven patients who had recurrence within one month, the underlying aetiologies were: post-TB sequelae in 5 patients (71.4%), bronchogenic carcinoma and aspergilloma in one patient (14.2%) each. Recurrence of haemoptysis occurred between 1 to 3 months in one patient of aspergilloma. Patients with post-TB sequelae had mild haemoptysis 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. The embolization materials used in patients who had recurrence within one month included: PVA in five patients (71.4%), coils in one patient (14.2%) and coils plus gel foam in one patient (14.2%). Only one patient who was embolized with PVA plus gel foam had recurrence between 1 to 3 months.

A study by Racil et al. [21] reported the short (< 30 days) and medium-term (> 30 days and < 3 years) recurrence rate of haemoptysis of 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 haemoptysis was also related to aspergilloma. Singhal et al. [22] reported aspergilloma as the cause of recurrence of haemoptysis in one patient during their one year of follow up.

Kim et al. [23] had used various embolization materials and reported re-bleeding in 32 patients. They used gel foam in 4 patients (12.5 %), coils in 5 (15.6 %), and gel foam and coils in 23 (71.9 %) patients. The reason of recurrent bleeding may be due to recanalization of previously embolized arteries and/or recruitment of new bronchial and non-bronchial arteries due to disease progression. In our study, three patients (10 %) had 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 %) developed local thrombus.

D'Silvaet al. [20] reported the following complications after embolization therapy: fever (12.5 %), chest pain (20 %), chest pain and fever (75 %), difficulty in passing urine (5 %), transient neuromuscular paresis (25 %). 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) were reported in one patient each. Thus, chest pain remains the most common post-embolization complication in the present as well as aforementioned studies. [25]

Conclusion

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

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 favour the simplest and the quickest procedure, the embolization therapy in controlling haemoptysis.

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