Original Article

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A Longitudinal Study Evaluating Indications, Efficacy and Complications of Bronchial Artery Embolisation

Internal Medicine Section

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ABSTRACT

Introduction: Embolisation is defined as the therapeutic introduction of Gelfoam or Poly-Vinyl Alcohol (PVA) particles into the circulation to occlude vessels. Selective embolisation of the bronchial arteries feeding the affected areas could be more effective than surgical intervention which is more hazardous leading to prolong Intensive Care Unit (ICU) stay, air leaks, stump infection.

Aim: To study various indications, success rate, complications, and recurrence after Bronchial Artery Embolisation (BAE).

Materials and Methods: The present longitudinal study was conducted in the Department of Pulmonary Medicine in collaboration with the Department of Interventional Radiology in Grant Medical College and JJ hospital, Mumbai, Maharashtra, India from December 2016 to December 2017. The study was done on 50 patients admitted in view of moderate to massive haemoptysis. Common indications requiring BAE, success rate with gelfoam or PVA particles, and common complications of the procedure were studied. Mean age of presentation with haemoptysis, co-morbidities associated with the disease were also studied. The patients were followed-up for six months. Repeat BAE was done in patients with PVA particles before referring for surgical intervention in cases with recurrent haemoptysis.

Results: The mean age of patients requiring BAE was 37.98 years, with male predominance. Most common indication was pulmonary tuberculosis followed by post-tuberculosis sequelae. The overall success rate of the procedure was 88% at six months follow-up.BAE done with PVA (10/10) particle showed a better outcome as compared to gelfoam (34/40). The most common complication related to the procedure was puncture site pain. Three patients out of six with recurrent haemoptysis required repeat BAE within three months, out of which only one required surgery.

Conclusion: The most common indication for BAE in this study was pulmonary tuberculosis. There were no major complications, even with repeat BAE. Hence, BAE should be the procedure of choice for moderate to massive haemoptysis despite of previous history of BAE, before considering for surgical intervention. BAE with PVA is associated with better success rate.

Keywords: Digital subtraction angiography, Gelfoam, Haemoptysis, Poly-vinyl alcohol, Pulmonary tuberculosis

INTRODUCTION

Embolisation is defined as the "therapeutic introduction of gelfoam particles or PVA particles into the circulation to occlude vessels, either to prevent haemorrhage; or to devitalise a tumour, or organ by occluding its blood supply; or to reduce blood flow to an arteriovenous malformation." Haemoptysis is a potentially life-threatening clinical event. Patients with chronic inflammatory lung diseases such as bronchiectasis, tuberculosis develop markedly hypertrophied and fragile bronchial arteries that may lead to clinically significant haemoptysis. Surgical intervention is hazardous and often impossible in the patients with diffuse parenchymal lung disease [1]. Selective catheterisation of the bronchial arteries followed by particulate embolisation is an effective treatment to control bleeding. BAE was first described by Interventional Radiologist Martine Remy-Jardin in 1973. Since then, the procedure has proven its safety and effectiveness in controlling haemoptysis in diverse lung conditions [2]. As BAE does not cure the primary disease, recurrent bleeding can occur, demanding additional embolisation procedures. Though surgery is a treatment of choice in conditions like aspergilloma, hydatid cyst, and thoracic vascular injuries; haemoptysis arising from these conditions can be potentially managed by endovascular approach. BAE in massive haemoptysis not only saves lives in emergency conditions but also bridges the time period before definitely elective surgical management can be undertaken [3]. Common causes of haemoptysis are tuberculosis, post-tuberculosis sequalae, aspergilloma, pneumonia, lung abscess, lung cancer, lung sequestration, bleeding disorders, traumatic. Pulmonary tuberculosis and aspergilloma are the most common indications requiring BAE [4].

This study was undertaken at a tertiary care centre with an aim to study common indications requiring BAE, overall success rate and complications and to assess recurrence occurring after BAE within a six months follow-up period.

MATERIALS AND METHODS

The present study was a longitudinal study, conducted in the Department of Pulmonary Medicine in collaboration with the Department of Interventional Radiology in Grant Medical College and JJ hospital, Mumbai, Maharashtra, India from December 2016 to December 2017. The study was approved by Institutional Ethics Committee (IEC) dated 30th November 2016 (423/2016).

Inclusion criteria: Fifty patients with massive haemoptysis who underwent BAE were selected. Both males and females were recruited for the study after taking informed consent. All patients above age of 18 years and with moderate to severe haemoptysis were included in the study.

Exclusion criteria: Patients who did not give consent were excluded from the study.

Patients were embolised with Gelfoam paticles or PVA. Sample size was calculated by non-probability convenient sampling.

All patients were enquired about the nature and duration of their illness and were examined and evaluated for haemoptysis. Haemoptysis was classified as: [3]

1. Mild- <20 mL/day
2. Moderate- 20-500 mL/ day
3. Severe/ Massive- >500 mL/day or 150 mL/hour or 100 mL blood loss per day for three consecutive days.

Detailed history of patients was taken with special consideration to the history of haemoptysis in the past and history of tuberculosis. Underlying co-morbid conditions like diabetes, hypertension, Human Immunodeficiency Virus (HIV), airway disease, anticoagulation, trauma, previous history of bronchial artery embolisation was noted. History regarding substance abuse and addiction was noted. All the patients were preliminary evaluated with investigations like Complete Blood Count (CBC), Blood sugar, Liver Function Test (LFT), Renal Function Test (RFT), Prothrombin Time (PT) and Iinternational Normalized Ratio (INR), Bleeding Time (BT), Clotting Time (CT), X-ray chest Posteroanterior view and Computed Tomography (CT) thorax with contrast. Sputum Acid fast Bacilli (AFB), gram culture and fungal culture, sputum Cartridge Based Nucleic Acid Amplification Test (CBNAAT) was done in the patients after haemoptysis was controlled.

All the patients were initially managed conservatively and attempts to stabilise the patients were made before referring for BAE. The procedure was done by an interventional radiologist in the Interventional Radiology Department (Digital subtraction angiography). Under all aseptic precautions, the right femoral arterial access was taken with 5 F catheter. Selective bronchial artery angiogram was done with Cobra catheter and blush was noted indicating a bleeding site. The study was conducted in a government set-up and because gelfoam particles were cheap and easily available as compared to PVA particles, embolisation was carried out using gelfoam particles in 40 patients and PVA particles in 10 patients only.

Postprocedure check angiogram was carried out to observe the previously bleeding vascular sites. All the patients were advised strict immobilisation for six hours after the removal of sheath. Intra and immediate postprocedure status were noted as puncture site haematoma, pain, or focal neurological deficit. All the complications were managed appropriately. Patients included in the study were reassessed monthly for six months. History regarding symptoms and recurrence of haemoptysis was taken and were managed accordingly. Haemoptysis, if controlled postprocedure and in six-months follow-up, was considered as a successful outcome. Persistant haemoptysis, even after the procedure or recurrence of haemoptysis within six months of the procedure was considered as a failure.

STATISTICAL ANALYSIS

Data was analysed using Statistical Package for the Social Sciences (SPSS)-16.0 software. Descriptive analysis was done on the collected data presented in the form of mean and percentage.

RESULTS

The study included 50 patients with haemoptysis who underwent BAE; gelfoam was used in 40 and PVA was used in 10, and all of them had moderate to massive haemoptysis. The youngest patient was of 18 years old and the oldest was of 69 years. The mean age was 37.98±14 years. Majority of the study population belonged to the age group of 18-30 years (42%) [Table/Fig-1].

Age groups (years)	Male (35)	Female (15)	Total (50)
18-30	13 (37%)	8 (53%)	21 (42%)
31-45	10 (29%)	1 (7%)	11 (22%)
46-60	9 (26%)	6 (40%)	15 (30%)
>61	3 (8%)	0	3 (6%)
Mean age±SD	37.98±14		

[Table/Fig-1]: Age and gender wise distribution of the patients.

The most common aetiology for undergoing BAE was pulmonary tuberculosis followed by post pulmonary tuberculosis fibro-cavitatory lesion. *Klebsiella* was the most commonly grown pathogen and 2 % patients were fungal culture positive for *Aspergillus fumigatus* [Table/Fig-2].

Diagnosis	Number of patients	Sputum Examination			
		AFB	CBNAAT	Pyogenic culture	Fungal culture
Pulmonary Tuberculosis	21 (42%)	13	19*	--	--
Post-tuberculosis Sequelae	15 (30%)	--	--	2**	--
Bronchiectasis	3 (6%)	--	--	4**	--
Fungal ball (Aspergilloma)	3 (6%)	--	--	--	1***
Lung malignancy	2 (4%)	--	--	--	--
Others ^	6 (12%)	--	--	--	--
Total	50 (100%)	13 (26%)	19 (38%)	6 (12%)	1 (2%)

[Table/Fig-2]: Diagnosis of the patients with Sputum examination.
^Patients with - Haemoptysis of unknown aetiology- 4, Alcoholic liver Disease -1, Coagulopathy -1
*3 patients were Rifampicin-resistant TB
***Klebsiella pneumoniae* in 3, *Streptococcus* spp in 2, and *Acinetobacter* in 1
*** *Aspergillus fumigatus*

The most common co-morbidity was diabetes, and six patients had multiple co-morbid conditions [Table/Fig-3]. Out of 50, two patients had previously undergone BAE with gelfoam particles -one patient had bronchiectasis who underwent BAE two years back and the other had Pulmonary Tuberculosis who had history of BAE eight months back. PVA particles were used in these patients.

Co-morbid conditions	Number of patients
Chronic Obstructive Pulmonary Disease	1
Hypertension	3
Diabetes Mellitus	4
HIV	1
Coagulopathy	1
Multiple co-morbid conditions *	6

[Table/Fig-3]: Co-morbid conditions.
*Patients with- diabetes mellitus, alcoholic and COPD-1,smoker, alcoholic and hypertension-1 diabetes mellitus and hypertension, alcoholic and COPD-2,alcoholic and hypertension-1

Post-BAE, all patients were followed-up for six months - haemoptysis was controlled in 10 (100%) patients in whom PVA particle were used, and in 34 (85%) patients in whom gelfoam particles were used. The overall success rate was 88%. The most common procedure-related complication was puncture site pain followed by transient chest pain [Table/Fig-4]. At six months it was noticed that 6 out of 40 patients (15%) treated with gelfoam particles had recurrent haemoptysis within three months. Recurrence was not seen in patients treated with PVA particles till the last follow-up [Table/Fig-5].

Complications	Number of patients (%)
Puncture site haematoma	2 (4)
Puncture site pain	24 (48)
Transient chest pain	6 (12)
Transient neurological deficit	1 (2)

[Table/Fig-4]: Complications.

Time for recurrence	Number of patients	Severity	Management	End result
1st Month	3	Mild/streaky	Conservative	Cured
2nd Month	2	Moderate	Repeat BAE with PVA	Cured
3rd Month	1	Severe	Repeat BAE with PVA	Required Lobectomy

[Table/Fig-5]: Recurrent haemoptysis and management during follow-up.

Patients were followed-up till six months post BAE and none had any recurrence after three months. Three patients had recurrent haemoptysis in 1st month of follow-up which was mild/streaky, two had recurrent haemoptysis in the 2nd month of follow-up

which was moderate and required repeat BAE with PVA particles. Both patients who underwent repeat BAE had control of bleeding and there was no recurrence at six months follow-up. Only one patient had severe haemoptysis in the 3rd month of follow-up which required lobectomy (Aspergilloma) even after repeat BAE with PVA particles [Table/Fig-5].

DISCUSSION

The study evaluated 50 patients with moderate to massive haemoptysis in whom BAE was performed at a tertiary care institute. It included 35 males and 15 females, with a mean age of 37.98 years. In the present study, pulmonary tuberculosis (42%) was the main aetiological factor for haemoptysis followed by post-tuberculosis sequelae (30%) which was similar to the studies conducted by Ramakantan R et al., [4], Tanaka N et al., [5], Mal H et al., [6]. However, in few other studies, the most common aetiology for haemoptysis were bronchiectasis and lung abscess [7,8]. In this study, bronchial angiography and subsequent embolisation for cases of moderate to massive haemoptysis was performed in the Interventional Radiology department by introducing gelfoam in 40 patients and PVA particles in 10. Ramakantan R et al., [4], used gelatin foam/gel foam particles, Corr PD [9] used tri-acryl microspheres, Baltacioğlu F et al., [10] used n-butyl-2-cyanoacrylate (NBCA), named 'glue', Rabkin JE et al., [11] used albumin macroaggregates as an agent for embolisation. Control of haemoptysis in the present study was achieved with embolisation with PVA particles 10 (100%) and with gelfoam particles 34 (85%) with total success rate of the procedure being 88% [Table/Fig-6] [4,6-16].

In a study by Hahn K et al., PVA showed a better success rate as compared to gelfoam, which was similar to the present study [14]. Fu Z et al., also reported good success rate of PVA as compared to Microspheres [13].

[Table/Fig-6] shows that the BAE is an effective procedure for control of haemoptysis immediately as well as in follow-up period, few studies showed that BAE done with PVA particles has better outcome in preventing recurrence as compared to gelfoam particles. Out of six patients who had recurrent haemoptysis in the present study, three were treated conservatively and three underwent re-embolization with PVA with successful outcome in two patients and one required Lobectomy. Overall recurrence rate after BAE was low, recurrence if occurred was re-embolized and had shown good outcome. Hahn S et al reported a recurrence rate of 37.5% with PVA, whereas Fu Z et al., reported it to be 0% [12,13].

Ramakantan R et al., studied 140 patients of whom 38 had recurrence; 29 patients were treated successfully with conservative measures and nine underwent re-embolisation with gelatin foam. Seven patients who underwent re-embolisation had recurrent bleeding; overall recurrence was 27.1% [4]. Recurrence in present study was 15% in patients treated with gelfoam particles, PVA particles showed 100% success rate. In the study by Baltacioğlu F et al., 3 out of 25 patients had recurrence in 12 month follow-up [10]. The study by Corr PD [9] showed 13% recurrence in one week follow-up. In a study on 46 patients, Mal H et al., found that immediate success rate was 93%, while the long-term success rate (beyond three months) was 54.34% [6].

Major causes of recurrence after successful BAE includes extrapulmonary-systemic collateral arteries [5], dislodgement of gelfoam particles, anomalous origin of bronchial arteries. Sancho C et al., observed 25 bronchial arteries of anomalous origin in their 27 patients with recurrent haemoptysis [17]. The most common procedure-related complication noted in the present study was puncture site pain (48%). It was managed conservatively with analgesics. Only one patient suffered transient unilateral lower limb weakness who showed improvement with physiotherapy within seven days.

Other studies found chest pain to be the most common complication [4,8,10,13]. Few patients had transient lower limb weakness but no major neurological complication was noticed [4,14]. Mal H et al., [6] showed mediastinal haematoma as a major complication in few of their patients.

S. No	Authors	Number of patients	Mean age (years)	Clinical success rate%	Most common aetiology	Clinical recurrence %	Complication rate%	Complication
1.	Ramakantan R et al., [4]	140 gelatin foam/gel foam particles,	31.5	73	Pulmonary Tuberculosis	27.1	27.8	Chest Pain
2.	Mal H et al., [6]	46	51	93	Pulmonary Tuberculosis	7	12	Mediastinal Haematoma
3.	Remy J et al., [7]	104	--	84	Lung Abscess	16	11.5	--
4.	Swanson KL et al., [8]	54	53	94	Bronchiectasis	24.1	7	Chest Pain
5.	Corr PD [9]	70 tri-acryl microspheres	--	87	Bronchiectasis	13	8.6	--
6.	Baltacioğlu F et al., [10]	25 n-butyl-2-cyanoacrylate (NBCA)	--	100	Lung Abscess	16	16	--
7.	Rabkin JE et al., [11]	306 albumin macroaggregates	--	90.8	Bronchiectasis	10	0.3	--
8.	Hahn S et al., [12]	430	56.7	PVA 62.5 Gelfoam 45	Pulmonary Tuberculosis	PVA 37.5 Gelfoam 55	--	--
9.	Fu Z et al., [13]	152	61.8	PVA 100 Microspheres 96.8	Bronchiectasis	PVA 0 Microspheres 3.2	PVA 32.2 Microsphere 25.8	Cough
10.	Han K, et al., [14]	84	--	82.1	Lung Cancer	17.9	--	--
11.	Uflacker R et al., [15]	64	--	76.6	Pulmonary Tuberculosis	24.4	10.9	Chest Pain
12.	Ingole S et al., [16]	40 Gelfoam	37	90	Pulmonary Tuberculosis	10	25	Chest Pain
13.	Present study	50	37.9	88 (100% with PVA 85% with Gelfoam)	Pulmonary Tuberculosis	12	Major 2% Minor 64%	Puncture site pain

[Table/Fig-6]: Compilation of published studies [4,6-16].

Limitation(s)

The sample size was limited, comparison between gelfoam particles and PVA particles was not done due to limited availability of PVA at the institute. Comparative analysis between surgical outcome (lobectomy) and non surgical procedure (BAE) was not done.

CONCLUSION(S)

Pulmonary tuberculosis and its sequelae remain the most common causes of haemoptysis requiring BAE in tuberculosis endemic countries followed by bronchiectasis, fungal ball, lung mass. BAE with PVA particles has shown better results in controlling moderate to massive haemoptysis than gelfoam particles. Pain at puncture site is the most common postprocedural complication, BAE is infrequently associated with major and life-threatening complications. Repeat BAE after the failed initial BAE or recurrent haemoptysis was also associated with a good success rate.

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