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Original Article

Bronchial artery embolization in treatment of hemoptysis: Treatment efficacy and complications at a tertiary care chest centre



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ABSTRACT

Background: Hemoptysis is one of the most alarming condition to both the patients suffering from it and the treating physicians. It is caused due to varied etiologies. One of the emergent and at times life-saving treatment option is by minimally invasive interventional radiological technique of Bronchial Artery Embolization (BAE). The authors aimed to carry out a retrospective analysis of short term efficacy and safety of all patients treated by this technique at a tertiary care thoracic centre.

Methods: A total of 52 patients were included in the study who had a median follow up of 35 days. All these patients were referred for hemoptysis, intractable hemoptysis not controlled by conservative management or massive hemoptysis. An analysis of the underlying etiology, immediate and short term outcomes and complications was made.

Results: The study showed Tuberculosis and its sequel (bronchiectasis and chronic fibrotic changes) as the commonest etiology (65%). The BAE showed high short term efficacy (92%) in stopping the hemoptysis with a relatively low complication rate especially of major complications such as spinal cord ischemia (1.9%). The study strengthens the limited Indian data available on the subject and based on its outcome, BAE should be tried in all patients presenting with uncontrollable or massive hemoptysis not getting relief by conservative management alone.

Conclusion: BAE is a very effective procedure with very less complications for management of massive or uncontrollable hemoptysis.

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Introduction

Hemoptysis is one of the most serious respiratory emergencies that may be life threatening and may require urgent management.^{1,2} Common causes in western population include non-tubercular bronchiectasis, fungal infections (aspergilloma), cystic fibrosis and sometimes advanced interstitial pulmonary fibrosis. Less common causes of massive hemoptysis include vascular malformations such as arterio-venous fistulae and neoplasms.¹⁻³ The most common etiology in Indian population is tubercular lung disease.^{2,3,6} The Bronchial Artery Embolization (BAE) has been used for emergency management for the treatment of hemoptysis. It was first described in literature by Remy et al.,⁴ in the 1970s and has been repeatedly published as an effective emergency therapy for treatment of hemoptysis in last few decades.⁵⁻⁸ The results of BAE have been analyzed by various studies in terms of short term and long term control of hemoptysis.⁹⁻¹⁵ We share our experience in patients who presented with acute hemoptysis at a tertiary care thoracic center and were treated by BAE, with an aim to assess the underlying etiology in these cases, immediate and follow up outcome and complications associated with the procedure.

Materials and methods

This study was undertaken at a tertiary care cardio-thoracic hospital. This facility is a tuberculosis and thoracic diseases center, with nationwide referrals.

Study design

It was a descriptive study which involved a retrospective analysis of cases presenting with hemoptysis at our center. All the patients who underwent the BAE from January 1, 2013 through May 30, 2016 were included. A retrospective medical record review of all the patients who had undergone BAE during this period was done where all the available medical records and radiographs or CT Scans were studied. Patients in whom the chest radiograph or CT scan did not show any obvious abnormality or were showing multiple pathological areas also underwent fiber-optic bronchoscopy to localize the possible region of lung from where hemoptysis was likely to occur and the bronchoscopic findings were noted. The angiographic findings, pattern and number of feeders and the embolization agent and method were noted. Immediate outcome (clinical change in hemoptysis up to one week) in all the treated patients was noted and their short term (up to last review or at one month) follow up in the hospital/OPD was also analyzed. Patient who were lost to follow up or whose records were not available were excluded.

The Bronchial Artery Embolization (BAE) technique

All BAEs were performed by trained interventional radiologists in the hospital interventional lab. A review of available imaging was done before each embolization which included chest radiograph, computerized tomography (CT) scan of chest

and prior bronchial angiogram (in case of repeat embolization). The suspected site of hemoptysis was localized based on the imaging findings and was specifically targeted for angiogram and embolization.

Angiography and embolization was done in all the cases through transfemoral arterial route under local anesthesia. The bronchial, intercostal and other relevant regional arteries were cannulated with various 5 French catheters, usually Cobra catheters for aortic branches and Head hunter or Picard catheters for subclavian branches. In most cases Glide catheters with hydrophilic coating (Terumo Inc, Japan) were preferred to avoid vascular trauma. At times, due to tortuous vascular access, various microcatheters (mostly Progreat, Terumo, Japan) were used to achieve safe distal location for embolization. Digital subtraction images were obtained after injection of iodinated contrast (Figs. 1b and 2b). Abnormal vascularity was identified in the form of presence of hypertrophied vessels, presence of abnormal vascular blush, areas of arterio-venous shunting and rarely, foci of active extravasation. Distal segment of vessels beyond the anticipated location of spinal arteries were targeted for embolization to avoid embolization of adjacent spinal arteries. The end point of embolization procedure was the disappearance of abnormal vascularity and the appearance of stasis in feeding vessels (Figs. 1c and 2c).

The commonly embolized arteries included the bronchial arteries, intercostal arteries, lateral thoracic artery branches and branches from thyrocervical and costocervical trunk. In most cases, embolizing material used was PVA particles (ranging from 300 to 750 μm); however, in few cases gelfoam slurry and pushable fibered metal coils (Cook, Inc., Bloomington, IN) were used. Initially smaller particles were injected, followed by larger size particles. All the patients were then observed in ICU for 24-48 h at least for immediate control of the bleeding post procedure and recurrence or any complication.

Analysis

The data was analyzed using SPSS ver 20 and expressed as mean or median for baseline data and as proportions for the various etiologies and the proportion of success and complications in the study subjects.

Results

Patient composition

A total of 52 patients underwent the BAE from January 1, 2013 to May 30, 2016. Follow up details of six patients was not available and these cases were excluded (Fig. 1). A total of 54 procedures were done on these 52 patients. The median follow-up was of 35 days (range 7-60 days). The mean (\pm SD) age was 48 years \pm 18. Forty three patients were males and nine were females (the hospital is referral center for large army population which comprises predominantly male personnel).

Clinical profile

Thirty six out of 52 patients presented with recurrent bouts of hemoptysis, not responding to medical treatment alone and

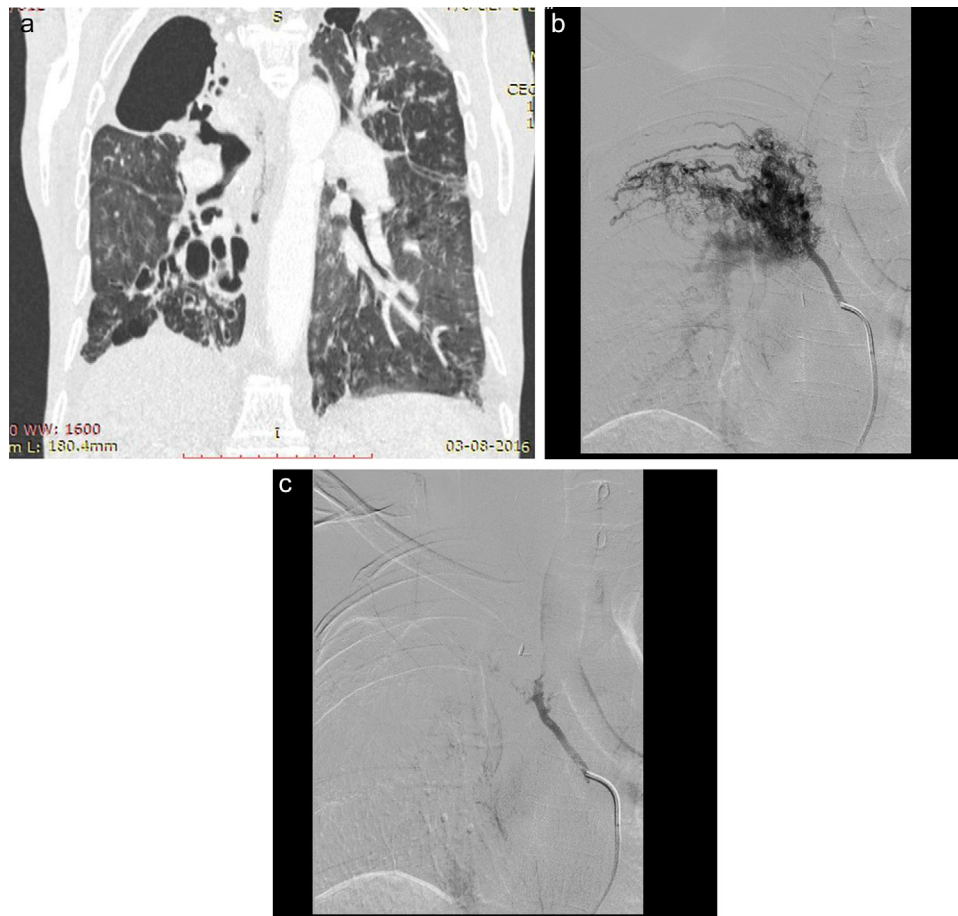


Fig. 1 – (a) CT scan image of a patient who presented with recurrent hemoptysis showing bronchiectasis and fibrotic changes in Rt lung with volume loss. (b) DSA done before BAE showed hypertrophied Rt Intercostobronchial trunk with significant abnormal vascular blush. (c) Post BAE DSA showing complete disappearance of abnormal vascular blush. Other feeders were also embolized in this patient (not shown here).

hence referred for embolization. 13 patient had large volume (>300 ml, defined as massive in some series) single episode which required urgent intervention, requiring resuscitation with fluids/blood transfusions, and were hypoxic or required intubation. The other presenting symptoms were dyspnea, cough, and chest pain. All the 52 patients had a pre procedure chest radiograph. Pre procedure CT Scan was available in all these patients which helped regarding the likely etiology. Four patients in whom the chest radiograph or CT scan were showing multiple pathological areas also underwent fiberoptic bronchoscopy to localize the possible region of lung from where hemoptysis was likely to occur. None of the patients were detected to have any bleeding disorder and all had normal International Normalized Ratio (INR) with value being less than 1.1.

Etiologic profile

Overall, post-tubercular bronchiectasis was the most common etiology (23/52, 44%). The next most common group was the non-specific chronic inflammatory sequel of chronic tuberculosis (11/52, 21%). Another common pathology was post tubercular cavity with fungal ball (7/52, 13%). Other less

common causes were pulmonary cavity without obvious fungal ball (4/52, 8%), non tubercular bronchiectasis – usually due to allergic broncho-pulmonary aspergillosis (3/52, 6%) and others (4/52, 8%) which included one case each of bronchogenic carcinoma, non-resolving consolidation (Table 1).

Immediate and short term outcomes of the Bronchial Artery Embolization (BAE) in controlling the hemoptysis

On immediate follow up (within 3 days of post procedure), total cessation of hemoptysis was achieved in 48/52 patients (92%). Two patients showed partial response with regression in hemoptysis which slowly improved with medical management including parental antibiotics. Both these patients had multiple feeders, few of which were close to vertebral artery origin and were therefore deliberately not embolized due to fear of posterior circulation stroke. Two patients required repeat BAE due to recurrence of significant bleed, one of these cases showed opening up of a prominent feeder embolized with gelfoam alone while the second case showed a prominent feeder which was missed in the initial BAE sitting. These patients showed good response after embolization with Poly Vinyl Alcohol (PVA) particles in second sitting. Most of the

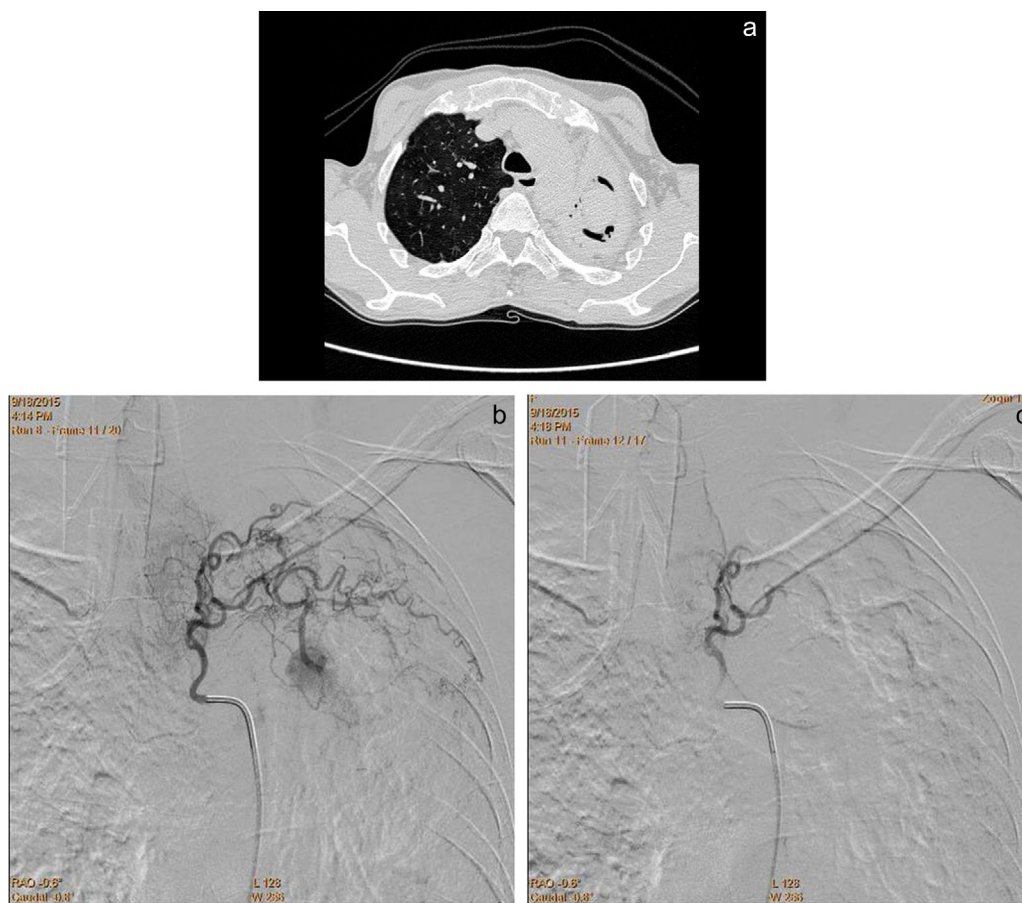


Fig. 2 – (a) CT scan image of a patient who presented with massive hemoptysis showing left upper lobar cavity with fungal ball. (b) DSA done before BAE showed hypertrophied left common intercostal trunk (giving rise to second and third intercostal arteries) with abnormal tortuous branches and a prominent vessel showing focal blush in the region of cavity probably indicating active extravasation. (c) Post BAE DSA showing complete disappearance of abnormal vascular blush.

Table 1 – Etiology of hemoptysis.

Etiology	n = 52	%
Tubercular bronchiectasis	23	44
Cavity with fungal ball	7	13
Chronic pulmonary TB changes (fibrosis, destruction)	11	21
Cavity	4	8
Non tubercular bronchiectasis	3	6
Others	4	8

patients were admitted for few weeks in the hospital this being the tertiary care center for such cases. On further short term follow up (up to a month), two patients had recurrence beyond 72 h. First patient showed good response to the next sitting of embolization after two weeks wherein additional prominent feeder not identified in initial Digital Subtraction Angiography (DSA) was picked up and embolized. However, the second patient had massive hemoptysis after about 10 days and succumbed to it and therefore could not be taken for DSA to identify the possible cause of recurrence.

Complications

The most common complication seen after the procedure was short duration chest pain or discomfort (5/52 patients), one patient had puncture site re-bleed which stopped after local compression. The most serious complication seen was in a patient who developed right lower extremity monoparesis after procedure (MRI scan showed a small focal spinal cord hyperintensity due to possible inadvertent spinal artery embolization). This patient slowly improved with physiotherapy and medical management and regained grade 4 power by the time of his discharge around 6 weeks after procedure. Only one person died due to recurrence of massive hemoptysis on 10th day as discussed above.

Discussion

Hemoptysis is one of the dreaded complication of multiple thoracic pathologies as mentioned before. Massive hemoptysis has generally been defined as bleeding more than 300 ml in a day^{1,2,6,7} and requires urgent intervention to save life of the

Table 2 – BAE in treatment of acute hemoptysis: literature review.

Year	Author	Number of patients	Agent used	Immediate success (%)	Complications (%)
1977	Remy et al. ¹	104	Gelfoam	84.0	11.0
1985	Uflacker et al. ⁹	64	Gelfoam, Ethanol, Cellulose, EACa ^a	77.0	11.0
1987	Rabkin et al. ⁵	306	PVA ^b /albumin/10% NaCl ^c	91.0	0.3
1992	Hayakawa et al. ¹¹	58	Gelfoam	87.0	7.0
1996	Ramakantan et al. ⁶	140	Gelfoam	73.0	27.0
1999	Mal et al. ¹⁰	56	Gelfoam, PVA, others	77.0	12.0
2000	Kato et al. ¹²	101	PVA, gelfoam, coils	94.0	6.0
2002	Swanson et al. ¹³	54	PVA, coils, gelfoam	94.0	7.0
2007	Poyanli et al. ⁷	140	PVA, coils	98.0	0.0
2010	Chun et al. ⁸	50	PVA	86.0	14.0
2011	Shin et al. ¹⁵	169	PVA (98), others (gelfoam, coils)	94.0	29.0 ^d
2016	Present study	52	PVA, gelfoam	92.0	1.9

^a E-amino caproic acid.

^b Polyvinyl alcohol.

^c Sodium chloride.

^d Including minor complications.

patient. Though definite treatment of hemoptysis requires prolonged medical management or surgical resection of diseased part of the lung, BAE fills in the gap by offering immediate control of the bleed and in many cases may prevent recurrent bleed in long term also.^{2,11-14}

We compared our data with other prominently cited published literature^{2,3,5-16} regarding the BAE that focused on the immediate bleeding control rate and complications (Table 2). The immediate success rates quoted in these studies is variable and was lower up to the year 2000 (generally less than 90%). This may be due to more frequent use of Gelfoam and embolic agents other than PVA which provides a longer occlusive effect and also by the availability of better catheters and microcatheters.

Our series had most of the cases due to tubercular or post-tubercular pathology. With regard to tuberculosis associated BAE, Ramakantan et al. published a data on 140 patients wherein successful outcome was seen in 102 patients (78%).⁶ More recently, Shin et al. in their series of 169 patients, described an immediate success of 94% in their series of 163 patients.¹⁵ Overall, the technical approach and outcome did not appear significantly different in cases related to tuberculosis. However, Shin et al. reported a higher recurrence rate in cases related to Tubercular etiology (29%) on further follow up. We did not have long term follow up in all the patients, but except few minor bleeding episodes, most of our patients did not have any major recurrence during the hospital stay.

The complication rates as seen in these studies have generally shown a declining trend over the years. The highest complication rates quoted are those by Shin et al. (29%) and Ramakantan et al. (27%), perhaps due to the reason that they included even the minor complications in their analysis. Most of the other studies show a complication rate of less than 10%. Our study had one major complication in the form of spinal cord focal ischemia leading to right lower limb transient monoparesis (1.9%) and other minor complications such as chest discomfort (5/54, 9%) and puncture site re bleed (1 patient, 1.9%). One patient died about 2 weeks after BAE attempt due to sudden massive hemoptysis, presumably due to an unidentified vessel which could not be embolized.

Overall, these results show good safety profile of the procedure with low incidence of clinically significant complications.

Bronchial artery embolization may be considered a durable long-term solution provided that the underlying pathologies treated.^{2,3,9-11} Patients with aspergilloma are reported to have high rates of recurrences and mortality, and may require even surgical resection of the affected lobe.¹⁷

Late recurrence of hemoptysis (3-6 months later) is likely to be due to incomplete embolization due to unsafe location of feeders (close to cerebral vessels) or an undetected arterial supply which may be missed initially or due to neovascularization from adjacent other arteries. Late recurrences (6-12 months after the BAE) have been reported in as many as 2-40% of patients, probably due to disease progression and collateral vessel formation.^{1-3,11} At the same time, many of the patients who have underwent BAE may not have any recurrence if the underlying disease process is adequately treated.

As seen above, BAE as interventional treatment option has been discussed previously in various studies (Table 2). However, our study showed certain peculiarities as compared to most of the other studies published previously. Firstly, this has one of the larger number of patients from a developing country as opposed to most of the data published previously which is from western literature. Secondly, our etiologic pattern as a cause of hemoptysis was totally different as compared to data available from western literature. In developed countries such as the United States, hemoptysis occurs due to a wide variety of causes including infectious (tuberculosis, aspergillosis) and non-infectious (cystic fibrosis, malignancy, vascular malformations) whereas in our study, we found most of these cases to be due to sequel of tuberculosis (bronchiectasis or cavity usually) which overwhelmed all other etiologies.

The procedural efficacy in controlling hemoptysis was comparable to other studies. Our immediate and short term success rates were comparable to those quoted in other studies. The study showed the procedure to be very safe. Only one patient had a major complication leading to monoparesis due to focal spinal cord ischemia as a result of non target embolization. Other minor complications such as short term

chest pain (5/52) or puncture site bleed (1/52) as discussed above had no significant clinical consequence. No vascular dissection was noted in our cases, possibly due to use of better catheters (4F/5F Cobra Glide catheter with hydrophilic coating manufactured by Terumo Inc, Japan were used in most cases). Spinal cord injury, subintimal dissection of the aorta, transient thoracic pain, and transient dysphagia are all well described in the literature.^{2,3}

The limitations of this study were its small patient population, availability of only short term follow up and its retrospective nature. Larger, more comprehensive studies in the future may further establish the efficacy and safety of this technique. A more prolonged follow up may also establish long term prognosis in these patients.

Conclusion

The study shows BAE to be an effective technique to control acute hemoptysis. In few patients with massive hemoptysis, it may even be life saving. However, in view of possible late recurrences, a concurrent adequate medical or surgical management may be required in many patients. The procedure may also be repeated many times in few patients who are poor surgical candidates due to high safety of the procedure.

Conflicts of interest

The authors have none to declare.

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