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Research Article

ROLE OF BRONCHIAL ARTERY EMBOLIZATION IN MASSIVE HEMOPTYSIS: A COMPREHENSIVE STUDY IN A TERTIARY CARE HOSPITAL

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A R T I C L E I N F O

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A B S T R A C T

Hemoptysis is a common medical concern of which massive hemoptysis is a medical emergency. Mortality is very high if not treated urgently. Majority of the massive hemoptysis are cryptogenic and management poses a moderately difficult task. Conservative management is ineffective in maximum number of cases. Surgery is not a good option because in most of the cases no definitive pathology has been found. Thus prompt and effective treatment is of crucial importance. Bronchial artery embolization is the treatment of choice in those cases. It was first described in the literature in 1970 by Remy[1] and over a period of time it has become a well established treatment for patients with massive hemoptysis.[2,3] We evaluated 14 patients with massive hemoptysis and studied the effectiveness of this interventional procedure that we carried out in this study. Embolization was performed in all patients using polyvinyl alcohol particles of 300-500 µm and in some cases with coiling. Hemoptysis was controlled in all patients after embolization. While recurrence of hemoptysis is a common occurrence, it was mild in cryptogenic hemoptysis in contrast to severe in non-cryptogenic hemoptysis. A repeat transarterial embolization is a safe and effective technique to manage those cryptogenic hemoptysis.

INTRODUCTION

In the cases of hemoptysis bleeding originates from respiratory tract, majority from upper airways and are not clinically important. Hemoptysis from the lower airways are of clinical importance especially those with life-threatening dimensions. Massive hemoptysis in non-traumatic patients has been reported to carry 35-85 percent mortality.[4] Death has also been reported mostly due to asphyxia. Hemoptysis is considered severe or massive when the total amount of expectorated blood exceeds 300-600 mL over a 24 hours period. [5] Hemoptysis is trivial when only drops of blood or bloody sputum are present, and moderate with a blood loss of less than 200 mL/24 hours. Without definitive treatment, recurrence is common with increasing fatality. [6] The source of blood may be bronchial (90%), aortic (5%) and non-bronchial systemic (5%). In most patients ofhemoptysis the underlying cause is chronic or acute inflammatory lung disease, including pulmonary tuberculosis, bronchiectasis, cystic fibrosis and aspergilloma. Etiology cannot be identified in 7%-22% of cases, and the condition is defined as cryptogenic hemoptysis. [7] The current study was performed to evaluateangiographic findings and BAE outcomes in massive hemoptysis.

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MATERIAL AND METHODS

Study Design

Prospective study

Setting

This study was conducted at Department of Interventional Radiology in Medical College, Kolkata, India

Duration of Study

The study was of 12 months duration after the approvalof synopsis. From January 2017 to January 2018

Ethics statement

The study was approved by the Institutional Ethical Committee (IEC) of the Medical College, Kolkata under WBUHS. Informed consent was waived by the board.

Sample size

14 patients

Sampling Technique

Non-probability consecutive sampling

Inclusion Criteria

Patients who had massive hemoptysis due to any cause

Exclusion Criteria

1. Those patients who had mild to moderate hemoptysis that can be controlled medically
2. Patient with known contrast allergy or any other contraindications of contrast administration like renal failure
3. Those who are at risk due to radiation exposure like pregnancy

Data Collection Procedure

Various angiographic findings and results of BAE were followed and efficacy of BAE was evaluated. Prior to the procedure, all patients were hospitalized, and stabilized with intravenous fluid replacement and blood products to correct the initial hypoxemia and hemodynamic instability. The chest radiography, thorax CT done in all patients and in some fiber-optic bronchoscopy to identify the cause of hemoptysis and to localize the site of bleeding.

Angiography was performed using the right femoral approach with a Philips Allura XPER FD20 DSA machine. First, non-selective angiography was performed with a 5F pigtail catheter to visualize the aortic arch and thoracic aorta and to delineate the bronchial artery anatomy and the presence of (if any) systemic collateral vessels. Then, a 4F or a 5F Cobra or Simmons catheter were used to catheterize the bronchial artery on the bleeding site and made visible by a non-ionic contrast (Iohexol) push. Ipsilateral intercostals arteriograms and, when necessary, subclavian arteriograms along with right and left internal mammary artery (RIMA and LIMA) were obtained by selective catheterizations. Bronchial angiographic criteria for hemoptysis are bronchial artery enlargement, hypervascularization, bronchial-to-pulmonary shunting, and extravasation of the contrast material into the bronchial lumen. Following super-selective catheterization of the bleeding bronchial artery or other culprit systemic artery mostly bymicro catheters, embolization was performed under fluoroscopic guidance by using 300-500 µm polyvinyl alcohol (PVA) particles mixed with non-ionic contrast or by using micro coils in some cases. Post embolization or post coiling angiography was performed to delineate the reduction of vascular blush in the affected region.

Statistical Analysis

The data was managed and analysed using SPSS version 22. All qualitative variables like gender of the study population are presented in proportionate pie diagram and age distribution in histogram. Various other significant data like smoking habits, disease distribution, CT & bronchial angiographic findings and lobar distribution of abnormal findings are also evaluated in frequency and expressed in pie diagram. Chi-square test was used to evaluate bronchial angiographic findings between the tubercular and non-tubercular hemoptysis groups. P-value <0.05 was considered as significant.

RESULTS

A total of 14 patients (12 men, 2 woman) with a mean age of 39.5yr (range, 15-72yr) with massive hemoptysis receiving endovascular treatment were evaluated. Of those, 8 patients (57%) were smokers.

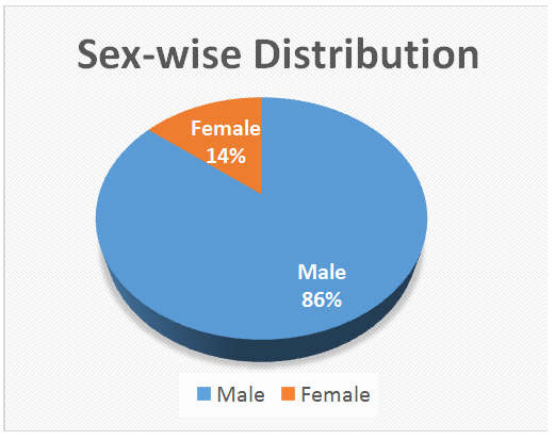

Figure 1 Pie diagram shows male : female distribution of the study population

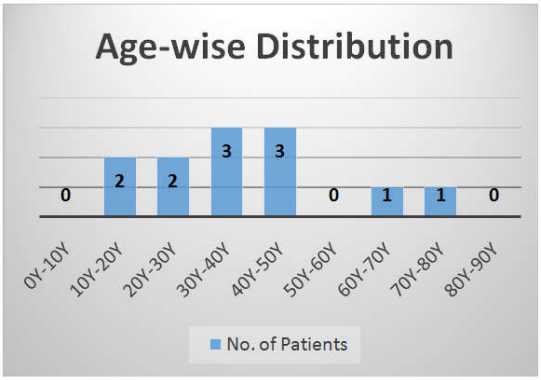

Figure 2 Histogram shows age distribution of the study population

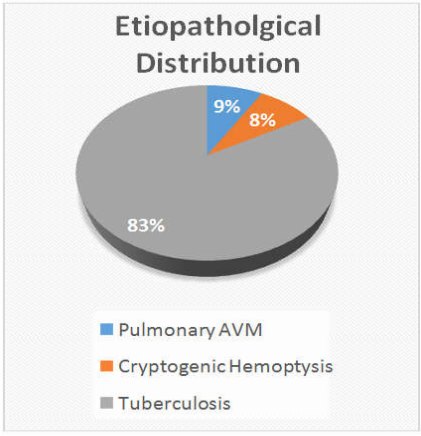

Figure 3 Pie diagram shows etiopathological distribution of hemoptysis in the study population

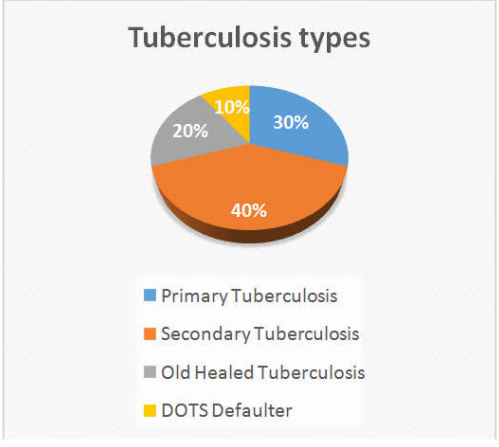

Figure 4 Pie diagram shows distribution of specific type of tuberculosis in study population suffering from tuberculosis

CT examination revealed bronchiectasis in 4 patients (28%), cavitary lesion in 1 patient (8.3%), pleuroparenchymal fibrotic changes due to tuberculosis in 6 patients (50%). All of the patients also had infiltrates and/or consolidation in the CT images. Of the patients with hemoptysis5 (35.7%) had unilateral lung abnormality, while 5 (35.7%) had abnormality in both lungs; moreover, 12patients (85.7%) had abnormality in more than one lobe.

Figure 5 Pie diagram shows distribution of subjects having smoking history in study group

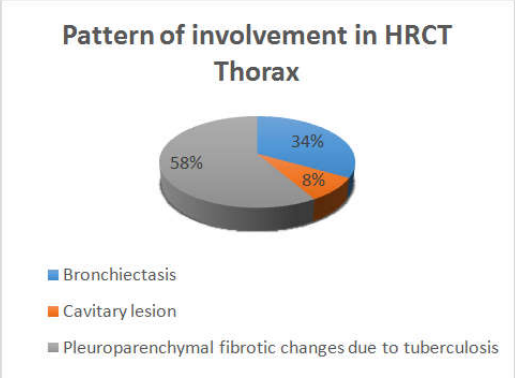

Figure 6 Pie diagram shows distribution of specific HRCT findings in the study population

We also evaluated various types of bronchial artery in study populations who were evaluated bilaterally (in all 14 patients). Type I circulation in 5 patients (36%), type II circulation in 4 patients (29%), type III circulation in 1 patients (7%), type IV circulation in 3 patients (21%) and common bronchial artery in 1 patient (7%).

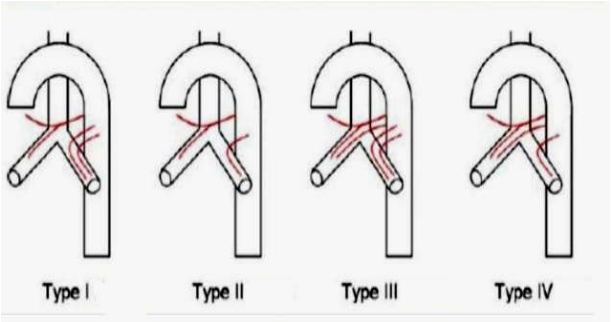

Figure 7 Schematic diagram showing anatomical variation Bronchial arterial anatomy.

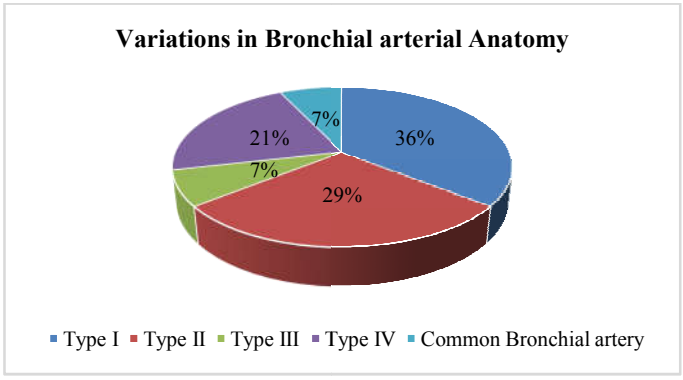

Figure 8 Pie diagram shows distribution of specific bronchial artery anatomical variants in the study population

Diagnostic angiography revealed abnormalities in all of the patients. While all of the patients had bronchial artery abnormalities, 2 (14.28%) also had non-bronchial systemic artery abnormalities, including abnormalities in the intercostal artery, thyrocervical trunk, internal and lateral thoracic artery. The most commonly detected abnormalities of the bronchial artery were dilatation in 3 patients (21.4%) and hypervascularity in all patients (100%). 4 patients (28.5%) had bronchial-to-pulmonary shunting while 6 (42.8%) had extravasation into the bronchial lumen. A comparison of the bronchial artery abnormalities between the tubercular and non-tubercular hemoptysis groups showed that only extravasation was statistically significant in the tubercular group than the non- tubercular hemoptysis group ($P < 0.05$), while the other bronchial artery abnormalities had no significant difference between groups (for all, $P > 0.05$).

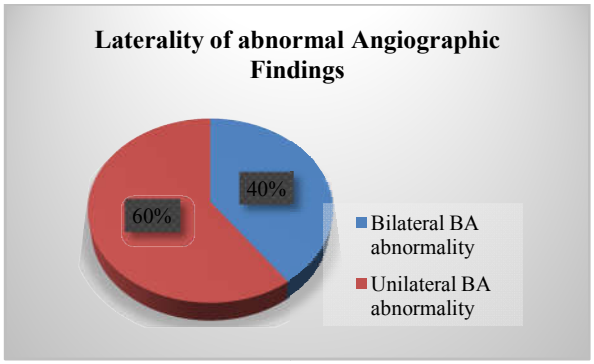

Figure 9 Pie diagram shows distribution of subjects having unilateral vs bilateral bronchial arterial abnormalities

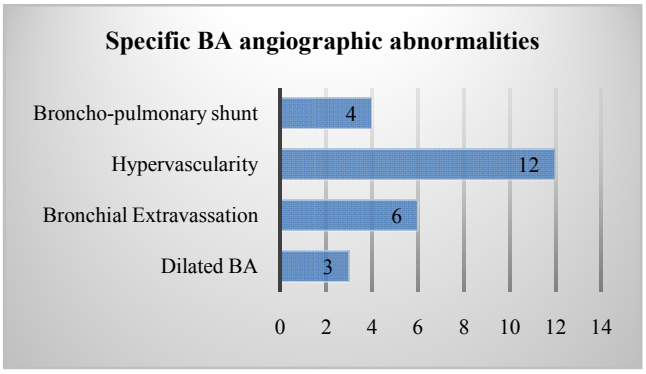

Figure 10 Bar diagram shows distribution of specific bronchial arterial angiographic abnormalities

Of the 5 patients with bilateral lung abnormalities in CT examinations, 4 (80%) had bilateral bronchial artery abnormalities in angiography. On the other hand, only 1 patient with bilateral lung abnormality who were investigated

for bronchial artery bilaterally had unilateral bronchial artery abnormality and that patient was non-smokers. Of the 9 patients with unilateral lung abnormalities, all were investigated for bilateral bronchial arteries, and out of which abnormality was identified in the contralateral bronchial artery in 3 cases.

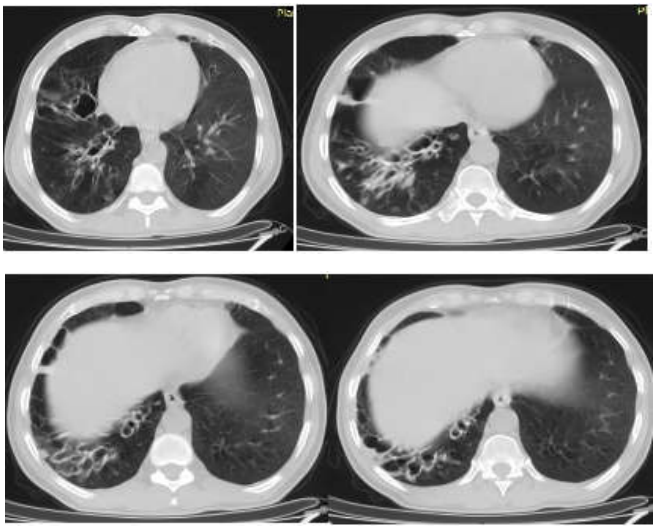

Figure 11 HRCT of 28 years male smoker with history of pulmonary tuberculosis shows characteristic right lower lobar cystic bronchiectasis

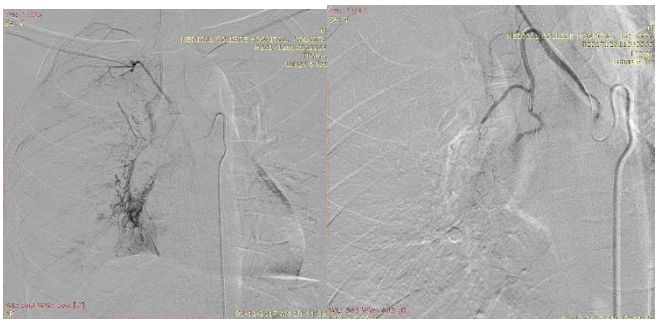

Figure 12 Left Bronchial arteriography (same patient as figure 11) shows abnormal blush with contrast extravasation in lower zone of right lung corresponding to abnormal neoangiogenesis with rupture of fragile vessels. **Right:** Post BAE with PVA particles shows significant reduction of blush

Because most of the patients had diffuse parenchymal disorders in the lung(s), they also had diffuse bronchial artery abnormalities. Only 2 patients (14.2%) had abnormality in one lobe of the lung in the CT images, and abnormalities in the ipsilateral bronchial artery branches on DSA. One of them was smoker.

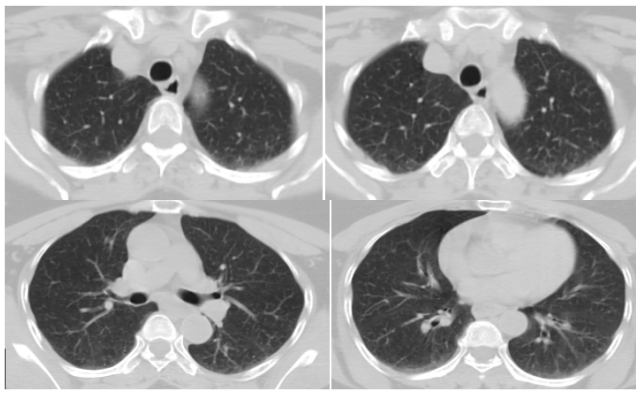

Figure 13 A 15 years female without any history of contact with tuberculosis presents with hemoptysis. HRCT was interpreted as normal.

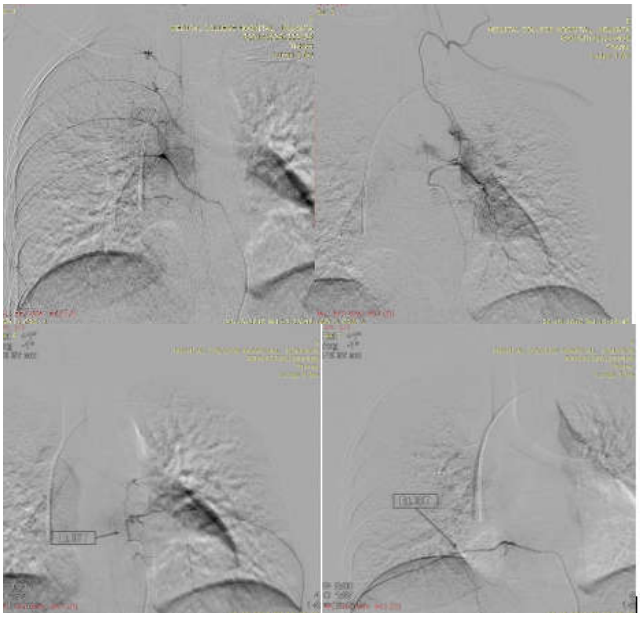

Figure 14 Above: On bronchial arteriography (same patient on figure 13), there is abnormal blush in bilateral mid zones. A negative history of tuberculosis favours the diagnosis of pulmonary Arterio-venous malformation. **Below:** Post BAE with PVA particles shows significant reduction of blush.

Hemoptysis ceased in all patients after embolization. No recurrence of hemoptysis was reported 2 months after the embolization in 14 patients (100%).

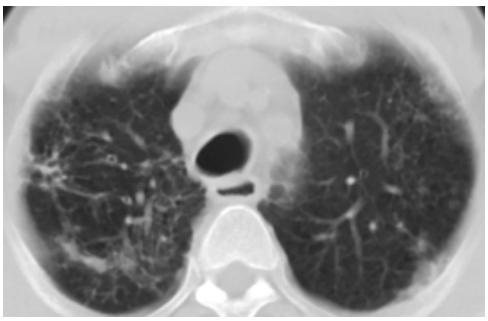

Figure 15 HRCT of 18 years male non-smoker with history of old healed pulmonary tuberculosis shows characteristic right upper lobar interstitial fibrosis.

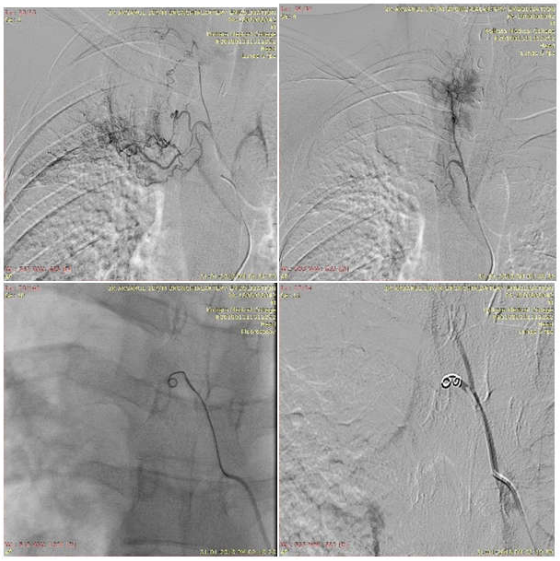

Figure 16 Left above: On bronchial arteriography (same patient on figure 15), there is abnormal blush in right upper zone. Right above: Post BAE with PVA doesn't show any significant reduction of blush. Left lower: Coiling is being performed in right bronchial artery that arises from right intercostobronchial

trunk. Right lower: Post coiling (using micro-coil), angiogram reveals significant reduction of blush.

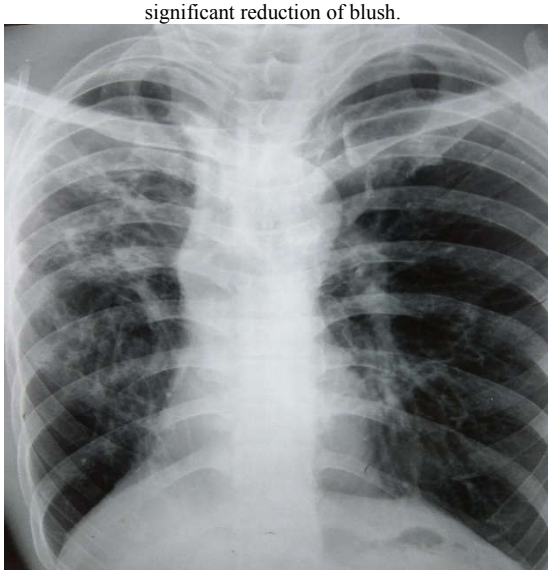

Figure 17 Chest X-ray PA view of 39 years male non-smoker with history of old healed pulmonary tuberculosis shows characteristic right upper and mid zonal fibrosis with ipsilateral mediastinal shift.

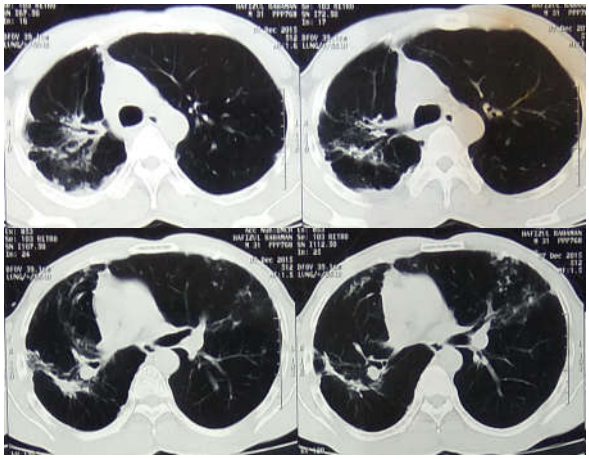

Figure 18 HRCT of same patient (figure 17) shows characteristic right upper and middle lobar interstitial fibrosis with traction bronchiectasis &ipsilateral mediastinal shift.

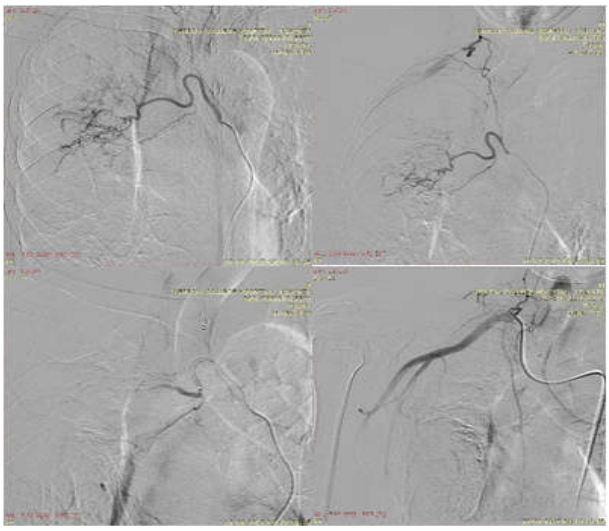

Figure 19 Left above: On bronchial arteriography (same patient on figure 17 and 18), there is abnormal blush in right upper zone. Right above: Post BAE with PVA doesn't show any significant reduction of blush. There is also abnormal communication noted between right subclavian and right bronchial artery. Left lower: Coiling is being performed in the feeding artery arising from right subclavian through bronchial connection. Right lower: Post coiling (using micro-coil), angiogram reveals significant reduction of blush.

DISCUSSION

Chest radiography and thoracic CT and sometimes bronchoscopy especially thoracic CT scan plays a vital role in identification of site of bleeding i.e. lobe and segments involved as well as possible cause of it. In cryptogenic hemoptysis, the cause of bleeding cannot be identified even if thoroughly investigated; infiltration and/or consolidation on the bleeding side parenchyma and liquefied material in the bronchial system are only CT findings. The current study revealed an Arterio-venous malformation on bronchial arteriography that resolved after BAE with coiling. The control CTs scan doesn't show any abnormality on arterial phase, indicating diagnostic angiography is even more sensitive in diagnosis of pulmonary Arterio-venous malformation.

The efficacy and safety of BAE in treating massive hemoptysis caused by various etiologies has been analysed. In 100% of cases, embolization stops the bleeding immediately, and 71.5% of patients do not have hemoptysis recurrences during one year of follow up. Those with recurrent hemoptysis (28.5%) have either post TB bronchiectasis or DOTS defaulter. Recurrent hemoptysis was treated medically with no subsequent recurrence in one year follow up. A limited number of studies evaluating the role of BAE in hemoptysisin post tubercular bronchiectasis have reported that bleeding stopped immediately after embolization in 72% of cases.[8,9] In one of these studies, 27% patients with a notable amount of bleeding after the procedure, 20% were treated successfully with conservative measures and 6% underwent re-embolization with success.

In our study, BAE was efficient in immediate control ofhemoptysis in all cases. Mild recurrence of hemoptysis occurred in three cases (28.5%), and medically managed. In none of them re-embolization was needed.

The angiography findings in massivehemoptysis cases cited in the literature are enlargement of bronchial artery, hypervascularization, retrograde bronchial-to-pulmonary shunting, and contrast extravasation into the bronchial lumen. [7, 10, 11, 12] In contrast, in our study, we found that contrast extravasation was the most commonly detected abnormalities whereas dilatation of the bronchial artery was the second most common abnormality which is consistent with previous study. All cases of contrast extravasation occur in patient with post tubercular hemoptysis and there is no statistical difference between tubercular and non-tubercular hemoptysis in case of bronchial artery enlargement.

Contrast extravasation is reported as the most common angiographic finding. In our study, on bilateral bronchial arteriography in patients with massive hemoptysis, the bronchial artery on the bleeding side was thicker than the ipsilateral bronchial artery only in 7.1% of cases. We conclude on the basis of this findings that hemoptysis could not be diagnosed solely based on this findings, other findings such as contrast extravasation into the bronchial lumen was more valuable and statistically significant as diagnostic findings.

An important finding of the current study was that 50% of patients with tubercular hemoptysis had bilateral disease out of all have contrast extravasation and dilated bronchial artery. Menchiniet *et al*.[12] reported bilateral bronchial artery abnormality in 76% of the patients who underwent bronchial arteriography bilaterally.

Anatomically, four classical bronchial artery patterns have been identified. [13] They are as follows (Fig – 7): Type I: Two bronchial arteries on the left, and one on the right (intercostobronchial trunk); present in 40 percent of cases. Type II: One bronchial artery on the left and one intercostobronchial artery on the right; present in 20 percent of cases. Type III: Two bronchial arteries on the left, and a bronchial artery and an intercostobronchial artery on the right; present in 20 percent of cases. Type IV: One bronchial artery on the left, and a bronchial artery and an intercostobronchial artery on the right; present in 10 percent of cases. On the contrary, we found type I circulation in 5 patients (36%), type II circulation in 4 patients (29%), type III circulation in 1 patients (7%), type IV circulation in 3 patients (21%) and common bronchial artery in 1 patient (7%).

In current study, another important finding was the abnormality of non-bronchial systemic arteries in 2 patients (14.2%). In literature it was cited that non-bronchial systemic artery abnormalities are observed during inflammatory conditions with the involvement of pleura.[13] In our study we found this non-bronchial systemic artery abnormality in patient with pulmonary tuberculosis with DOTS defaulter. As this occurrence is suggestive of less prevalent we could not say whether this is statistically significant or not.

Angiographic findings show us that there is bilateral affection in both tubercular and non-tubercular massive hemoptysis, however there is no statistical significance in bilateral bronchial artery abnormality in tubercular group compared to non-tubercular group. No causal relationship was found with smoking. In contradiction to our study, recent study shows the relationship between smoking and tubercular hemoptysis. [7, 12] Smoking induces inflammatory changes mostly in the upper zones of the lungs. [12,14,15] Supporting this, a study reported bleeding in the upper lobes in 71% of the tubercular hemoptysis cases in smokers. [12]

The goal of BAE is to stop high pressure systemic arterial inflow into newly formed fragile vessels in the pathological region of the lungs, thereby perfusion pressure is decreased and prevent bleeding.[16] The objective is to occlude the distal vascular bed in endovascular treatment of hemoptysis, and for that, PVA particles are used as the embolic material. Absorbable gelatin sponge can be used for embolization; but as it may be resorbed over time and recanalizes. It is not a preferable embolic material for hemoptysis control. PVA is biocompatible and nonbiodegradable which provides permanent embolization. [17] No significant complications were encountered, either during or after the procedure. However we had to perform coil embolization in two cases of tuberculosis who shows significant bronchial artery enlargement with multiple collaterals coming from bronchial artery and broncho-pulmonary fistula. Tris-acryl-gelatin microspheres also are being used now as embolization material in BAE which significantly stops bleeding. [10] It has added advantage – it doesn't form plug within the catheter.

The complications of BAE are rare and can be related to either the femoral arterial injury, catheterization, embolization or contrast related complications. The main complications related to femoral arterial puncture are arterial occlusion, perforation, dissection, pseudoaneurysm, hematoma, arteriovenous fistula. Sometimes breakage of catheter tip has also been reported. Non-target embolization and postembolization syndrome are related to selective catheterization and embolization. Chest pain due to intercostal artery embolization or dysphagia due to oesophageal branch blockage are of main concern. Paraplegia is a major known risk for BAE. A spinal arterial communicating branch with bronchial artery may be observed and super-selective catheter are used to avoid the blockage of this branch. Rare complications reported in literature include aortic and bronchial necrosis,[18] bronchial stenosis,[19] unilateral diaphragmatic paralysis,[20] pulmonary infarction (especially in patients who have suffered pulmonary artery embolism), left main bronchial-oesophageal fistula,[21] and non-target embolization (colon, coronary and cerebral circulation).[22] In our study, no such significant treatment complications occurred.

This study focused only the patient with massive hemoptysis and mild to moderate hemoptysis who are managed conservatively were excluded from the study. So, we cannot includes the other major pathologies which may show abnormalities in bronchial arteriography. This was the major drawback. The study sought to evaluate arterial abnormalities in massive hemoptysis patients and embolization results in those patients particularly of tubercular group.

CONCLUSION

1. Contrast extravasation is one of the most commonly observed angiographic findings, yet bronchial artery enlargement, hypervascularization andbronchial-to-pulmonary shunting are considered valuable and significant.
2. Non- bronchial systemic arteries can also be affected in tubercularhemoptysis.
3. BAE is an effective and reliable treatment option for massivehemoptysis, with excellent short-term and long-term results.
4. Knowledge of bronchial and non-bronchial systemic circulation with prior CT imaging is mandatory to locate the site of bleeding with higher rate of technical success and to reduce complications.
5. Post embolization recurrence can be mild to moderate which should usually managed with conservative treatment. Few cases may require repeat embolization. The patients and patient's relatives should be properly counselled before the initiation of BAE.

Acknowledgement

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