Bronchial Artery Embolization for Hemoptysis

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Abstract

Background : Massive hemoptysis is a life-threatening condition. Since treatment from surgery has high mortality, bronchial artery embolization (BAE) is now safer and may be good for chronic hemoptysis as well.

Material and Method : Ten patients (6 male, 4 female) with hemoptysis underwent BAE. Five patients had massive life-threatening hemoptysis (4 tuberculosis and 1 bronchogenic carcinoma) and 5 had chronic hemoptysis (4 tuberculosis and 1 bronchogenic carcinoma). All patients received BAE by transfemoral arterial approach using gelfoam particles and Ivalon as the embolized materials. Bronchial arteries were abnormal in all cases except one patient who had bronchogenic carcinoma supplied by the acromiothoracic artery to the left upper lobe.

Results and Conclusion : Chest radiograph may correlate well with angiographic findings if there is one lobar lesion, but multiple lobar lesions showed no correlation between the two modalities. Hypervascularity was a universal findings in all patients. Other angiographic findings were enlarged bronchial or nonbronchial arteries, systemic to pulmonary anastomosis, pseudoaneurysm, and extravasation of contrast media. The immediate result of BAE achieved 100 per cent but follow-up showed only a 70 per cent success rate with one mortality from recurrent massive hemoptysis and two recurrent cases due to complications. Ivalon which is a permanent embolized material may be useful for recurrent hemoptysis.

Key word : Bronchial Artery, Embolization, Hemoptysis

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Bronchial artery embolization (BAE) is a well-accepted and widely-used procedure for the management of massive or recurrent hemoptysis (1-5). Massive hemoptysis is defined as the expectoration of more than 300 ml of blood in 24 hours (6). It is a major clinical and surgical problem, related to high mortality(7) usually due to either hypovolemia or asphyxiation or both. The mortality rate of massive hemoptysis may be as high as 50-100 per cent which may rapidly lead to death (8,9). Until recently, early surgical resection was considered to be the treatment of choice(10,11). Nevertheless, surgery during an episode of massive hemoptysis carries high mortality and morbidity with operative bleeding asphyxia, bronchopleural fistula and respiratory failure(12,13). In the 1970's, Wholey et al(4) and Remy et al(2) described the use of transcatheter embolization of the bronchial or pulmonary arteries or both to control hemoptysis of diverse etiologies. Since then, many articles have been presented regarding the success and complications of BAE(5,6,8,9).

The objective of the paper were :

1. To describe the method, and the experiences of BAE in patients with massive hemoptysis.
2. To analyse the chest findings and angiographic findings of patients with chronic and massive hemoptysis.
3. To state the results of patients with massive hemoptysis after BAE.
4. To evaluate the use of BAE on patients with chronic intermittent hemoptysis.

MATERIAL AND METHOD

Ten patients with hemoptysis were included in this study. There were 6 male and 4 female, patients aged 22 to 75 years (mean 48.5). 8 tuberculosis and 2 bronchogenic carcinoma.

Patients were classified into two groups. Five patients were included in group 1 with massive hemoptysis (the rate of bleeding was more than 300 ml in 24 hours). The clinical presentation and basic disease are summarized in Table 1. All patients in this group had life-threatening hemoptysis with shock, recovery from shock or impending shock during BAE. Four patients had active tuberculosis (positive acid fast bacilli via sputum examination) with adequate treatment of tuberculosis. One patient in this group concomittently developed stage 3 bronchogenic carcinoma involving the pulmonary trunk as demonstrated by CT chest (Fig. 1).

Group 2 included 5 patients with chronic intermittent hemoptysis as noted in Table 2. Four had tuberculosis; 1 bronchogenic carcinoma, advanced stage. The clinical presentation of patients was chronic cough with occasional hemoptysis of a half to one cup of bloody sputum once or twice a week. Most of these patients had received either a complete course or incomplete course of anti tuberculous drugs with irregular follow-up as outpatients. Patient number 7 (Table 2) who received

Table 1. Shows the clinical presentation, treatment and result of patients with massive hemoptysis.

Case No.	Sex / Age	Basic Disease	Clinical Presentation	Treatment	Result	
					Immediate	Long term
1	M / 56	Bronchogenic CA	Massive hemop. 1 day Recovery from shock	BAE+Radiation	Success	9 months No recurrent
2	M / 53	TB	Massive hemop. 1 HR Recovery from shock	BAE+Chemo	Success	9 months No recurrent
3	F / 72	TB	Massive hemop. 1 day with shock	BAE+Chemo	Success	Dead from Recurrent in 2 wks
4	F / 34	TB	Massive hemop. 1 day with shock	BAE+Chemo	Success	7 months No recurrent
5	M / 22	TB	Massive hemop. 1 day impending shock	BAE+Chemo	Success	Follow up 1 month No recurrent

BAE = Bronchial artery embolization

Chemo = Chemotherapy

no medication on admission for BAE due to negative acid fast bacilli in sputum examination still had chronic cough with hemoptysis off and on.

All patients in both groups had chest roentgenogram or CT scan of the chest taken prior to BAE. Only one patient (case 6, Table 4) had bronchoscopic examination done, prior to BAE.

Percutaneous transfemoral catheterization was used in all examinations. The cobra head shape (7) or Chuang type(14) catheters were used in all cases into the bronchial, intercostal and subclavian arteries using Hexabrix (loxaglate)(8,15), or Ultravist (lopromide)(16) contrast media.

All cases were examined in the digital subtraction angiographic unit. Every radiographic image was thoroughly examined by the attending interventionists for the presence of anterior spinal arteries arising from bronchial or intercostal arteries which may be contraindicated for BAE(17) except in case 5 in which the microcatheter was introduced inside a cobra head catheter beyond the bronchial artery orifice for BAE. The arteries to be occluded were chosen from radiological, endoscopic and angiographic findings. The tip of the angiographic catheter had to be positioned at least 2 to 3 mm beyond the orifice and angiographic examination; angiographic testing was made in order to avoid reflux of embolized materials to nontarget organs. The volume of low osmolar contrast media to be injected had to be less than 8 ml for each angiographic injection. The embolized material was gelfoam particles (surgical gelatin)(18) in most cases. Two patients with recurrent chronic hemo-

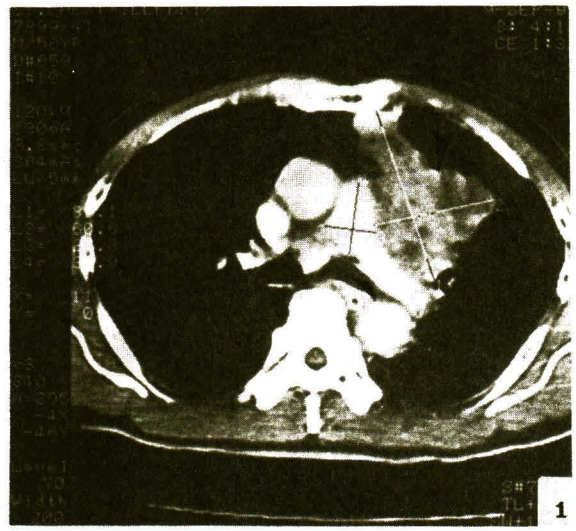

Fig. 1. Enhanced CT chest of case 1 with bronchogenic carcinoma shows an irregular mass at the left upper lobe invading the left pulmonary trunk. (Big arrow)

Table 2. Shows the clinical presentation, treatment and result of patients with chronic hemoptysis.

Case No.	Sex / Age	Basic Disease	Clinical Presentation	Treatment	Result	
					Immediate	Long term
6	M / 75	TB (AFB +ve)	Chronic cough 2 yrs Hemop 1-2/mo (I cup)	Chemo 2 yrs	Success	7 months No recurrent
7	M / 42	TB (AFB -ve)	Chronic cough 8 yrs Hemop 7 yrs (I cup)	Chemo 8 yrs Irrggular FU.	Success	9 months No recurrent
8	F / 53	TB (AFB +ve)	Chronic cough 2 yrs Hemop 2 mo (I/2 cup)	Complete chemo stopped med 6 mo.	Success	1 month recurrent FU 2 months after repeat BAE
9	M / 59	TB (AFB +ve)	Chronic cough 5 mo Hemop 2 mo (I cup)	Chemo 5 mo.	Success	1 month recurrent FU 2 months after repeat BAE
10	F / 56	Bronchogenic CA	Chronic cough 2 mo Hemop I cup	Radiation therapy	Success	1 month FU No recurrent

Chemo = Chemotherapy BAE = Bronchial artery embolization
FU = Follow up TB = Tuberculosis, AFB = Acid-fast bacelli

Table 3. Shows the result of angiographic findings in patients with massive and chronic hemoptysis. The number of cases and percentage and angiographic findings are listed.

Angiographic findings	No. of patients	%
Hypervascularity	10	100
Enlargement of arteries	7	70
Pseudoaneurysm	2	20
Systemic to pulmonary Anastomosis	5	50
Extravasation	3	30

Table 4. Shows the correlation of chest and angiogram of all patients with hemoptysis.

Case #	Basic Disease	Chest	Angiographic lesion + BAE
1	Bronchogenic CA	LUL	Lt Acromiothoracic
2	TB	RUL, RLL	Lower, intercostobronchial
3	TB	RUL, LUL	LUL BA.
4	TB	RUL, RLL, LUL	LUL BA.
5	TB	RUL, RLL	RUL BA., RLL intercostobronchial
6	TB	Scope bleeding RUL RUL with cavity, LUL	RUL BA with aneurysm
7	TB	RUL, LUL	LUL BA.
8	TB	LUL, LLL	LUL, LLL, BAE of LLL BA
9	TB	RLL with PE, LLL	RLL BA.
10	Bronchogenic CA	RUL	RUL intescostobronchial artery

Abbreviation :

TB = Tuberculosis LUL = Left upper lobe RUL = Right upper lobe
RLL = Right lower lobe PE = Pleural effusion BA = Bronchial artery
BAE = Bronchial artery Embolization

ptysis (cases 8, 9) and one patient (case 10) with chronic hemoptysis from bronchogenic carcinoma received Ivalon (polyvinyl alcohol)[19] size 300-600 micron as embolized material with successful results (Fig. 2, Fig. 3).

RESULTS

The results of both groups including basic disease and the mode of treatment are summarized in Tables 1 and 2. Immediate control of hemoptysis was achieved in all 10 patients by BAE, with lasting control being 70 per cent. The follow-up period ranged from 1 to 9 months.

On follow-up treatment, the 2 patients with bronchogenic carcinoma in both groups were treated with radiation after recovering from hemoptysis with BAE and showed no recurrent hemoptysis. One patient with massive hemoptysis in group 1 (case 3) died from recurrent massive hemoptysis 2 weeks after BAE. Autopsy was not performed. Two patients in group 2 (cases 8 and 9) had recurrent hemoptysis in one month following BAE and repeat BAE was performed using Ivalon with good results without any recurrence at follow-up within 2 months (Fig. 4). Table 3 summarizes the angiographic findings of systemic bronchial (9

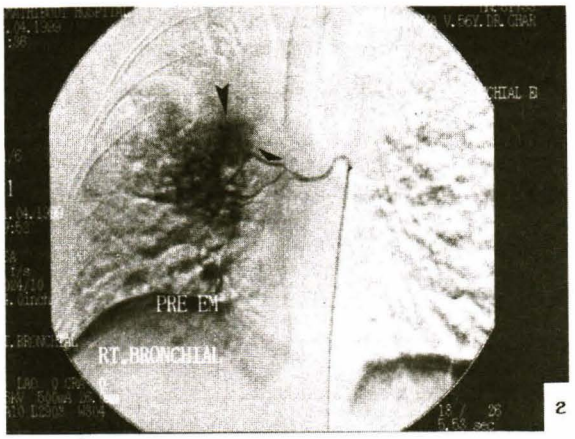

Fig. 2. Case 10. Bronchogenic carcinoma with hemoptysis, right bronchial angiogram (small arrow) reveals hypervascularity of the tumor. (Big arrow)

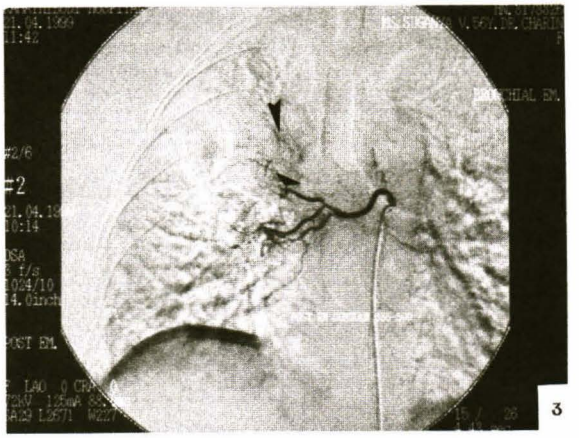

Fig. 3. Case 10. Post bronchial arterial embolization of tumor feeder with Ivalon shows occlusion of the feeder (small arrow) with no hypervascularity seen. (Big arrow)

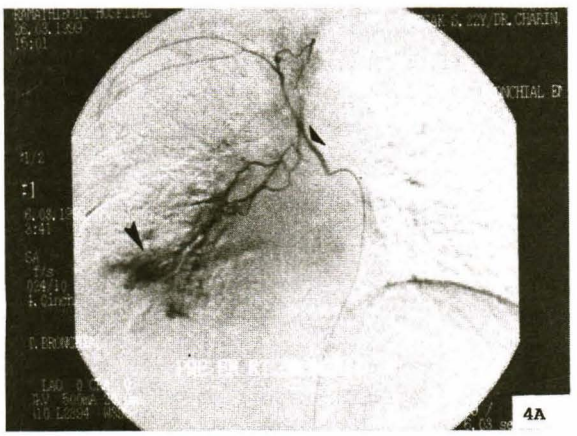

Fig. 4A. Case 9. Chronic tuberculosis with chronic recurrent hemoptysis one month after first BAE, repeat right bronchial angiogram (small arrow) shows hypervascularity of inflammatory lesion of right lower lobe. (Big arrow)

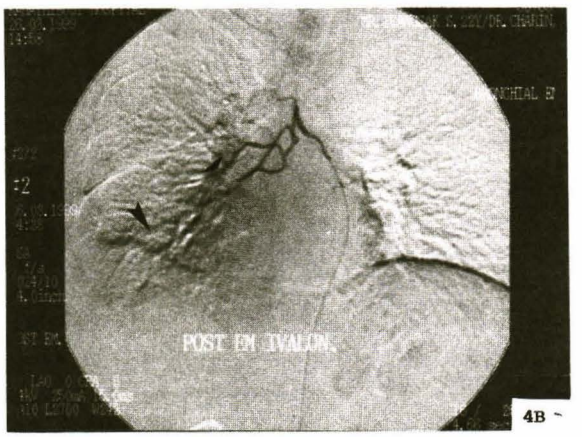

Fig. 4B. Case 9. Post BAE with Ivalon shows complete occlusion of feeder arteries (small arrow) with no lesion. (Big arrow)

cases) and non-brochial (1 case) angiographic findings. Hypervascularity (100%) and enlargement (70%) of arteries were the most common angiographic findings with systemic pulmonary anastomosis, extravasation and pseudoaneurysm accounting for 50, 30 and 20 per cent respectively. Table 4 shows the relationship of the chest radiograph to the angiographic lesion. Two cases with bronchogenic carcinoma showed a lesion in the chest roentgenogram in one lobe which was compatible with the angiogram. For those cases with multiple locations of lesions, the chest radiograph and abnormal

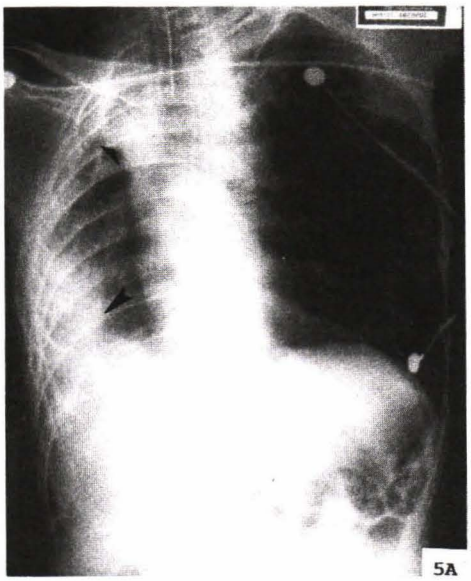

Fig. 5A. Case 2. Massive hemoptysis from active tuberculosis, chest radiograph shows lesion in right upper lobe (small arrow) and right lower lobe (big arrow) which cannot well establish the exact lobar location of bleeding hemoptysis.

angiographic lesion that needed BAE may not correspond to each other. For example, in case 2 pulmonary tuberculosis occurred in the right upper and right lower lobes but the only abnormal angiographic lesion was seen in the right lower lobe intercostobronchial artery (Fig. 5).

DISCUSSION

The most serious complication of BAE is spinal infarction or transverse myelitis[20] due to embolized material in the anterior spinal artery. To avoid the complication, low osmolar water soluble contrast media such as iopromide or ioxaglate were used which is considered to be less neurotoxic than the ionic, high osmolar contrast media[13,15,16]. The volume of contrast media should be minimal, not more than 8 ml for each injection. Digital subtraction angiographic unit should be obtained and a thorough evaluation for the presence of anterior spinal artery arising from intercostobronchial or intercostal arteries should be made prior to BAE. For the 10 cases of BAE, no serious complication was demonstrated. The most common complication encountered was chest pain in a few patients lasting up to 36 hours. The pain corresponded to the vascular territory embolized. It was a self-limiting

Fig. 5B. Case 2. Arterial catheter is at right intercostobronchial trunk, note, the upper lobe bronchial artery is normal (small arrow). There is enlarged right lower lobe bronchial artery (two small arrows) supplying lesion in right lower lobe with hypervascularity, early AV shunt and extravasation. (big arrow)

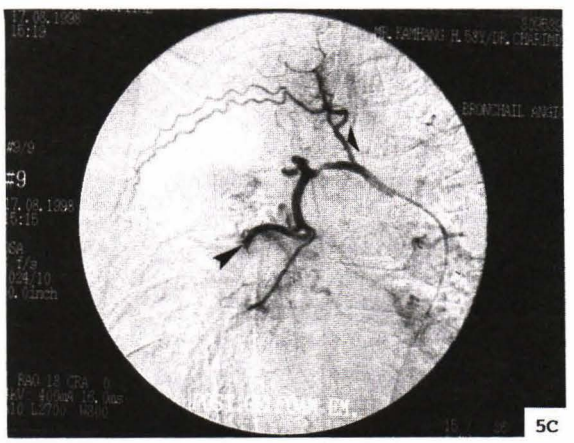

Fig. 5C. Case 2. Post BAE with gelfoam particles shows occlusion of lower lobe bronchial artery with no lesion (big arrow). Note normal appearance of right upper lobe bronchial artery and its branches. (small arrow)

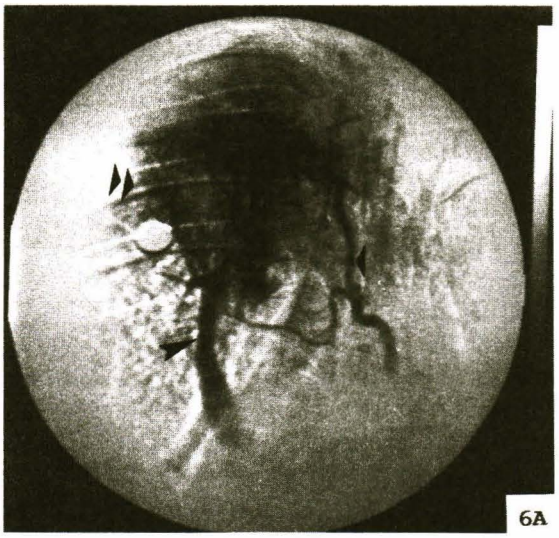

Fig. 6A. Case 5. Massive hemoptysis from active tuberculosis, right upper lobe bronchial angiogram shows enlargement of the feeder (small arrow), hypervascularity of lesion (two small arrow) and systemic to pulmonary anastomosis. (big arrow)

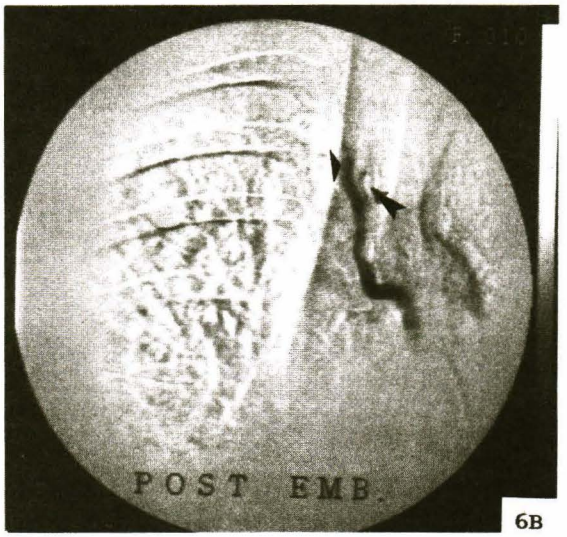

Fig. 6B. Case 5. Post selective embolization with gelfoam particles shows occlusion of the distal end of the feeder (small arrow). With the aid of microcatheter the small spinal artery, proximal to embolized artery is left intact. (Big arrow)

process with symptomatic treatment only. As noted in Table 3, hypervascularity is the most common angiographic finding in all cases and may be the only angiographic finding seen in some cases in group 2 with chronic hemoptysis (cases 7-10) which correlates quite well with other articles[3, 21] and may be considered to be the abnormal artery needed to be embolized. Enlargement of bronchial or systemic arteries was also common but usually accompanied by hypervascularity of arteries. Bronchial to pulmonary anastomosis is quite common (about 50%) which is not contraindicated for BAE and was successfully done in case 2 and case 5 (Fig. 6). Pseudoaneurysm, although an important indicator of the source of bronchial bleeding (Fig. 7), was seen infrequently (only 20%). The frequency of the finding may be even less than extravasation of bronchial artery (30%), another important indicator of active bronchial bleeding (Fig. 5B).

In case 1 with bronchogenic carcinoma, there was an abnormal systemic nonbronchial artery (acromiothoracic) which arose from the left subclavian artery and supplied the lesion in the left upper lobe. This patient had no hemoptysis after embo-

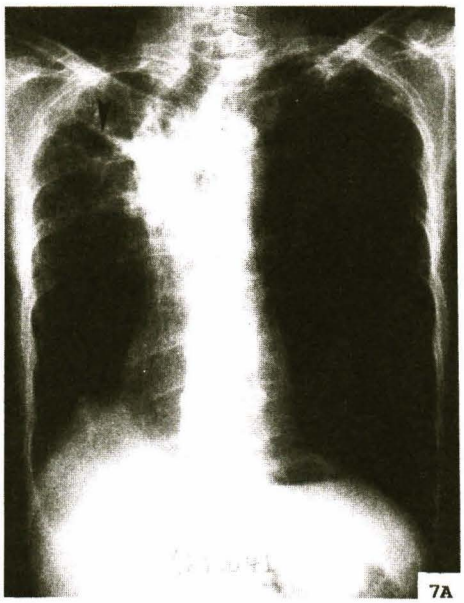

Fig. 7A. Case 6. Chronic hemoptysis from active tuberculosis. PA chest shows cavitary lesion at right upper lobe (Big arrow) which is considered to be a sign of active tuberculosis.

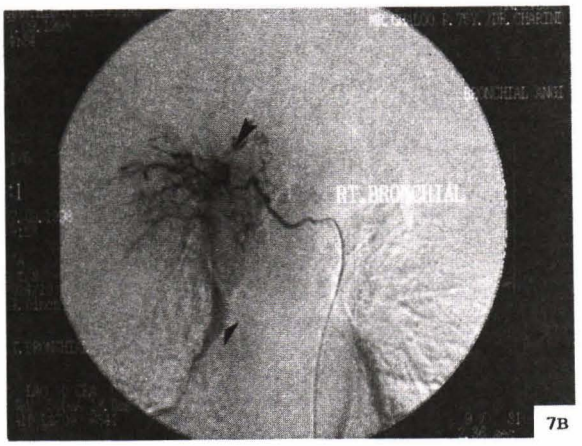

Fig. 7B. **Case 6. Right upper lobe bronchial angiogram reveals pseudoaneurysm at the lesion right upper lobe (Big arrow) exactly corresponding to cavitary lesion in Fig. 7A, bronchial to pulmonary anastomosis also noted. (small arrow)**

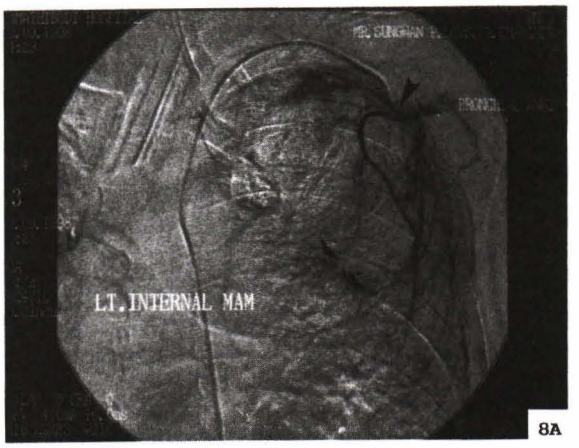

Fig. 8A. **Case 1. Bronchogenic carcinoma with massive hemoptysis as in Fig. 1A and 1B, arterial catheter is at origin of left acromiothoracic artery (Big arrow) with extravasation of lesion indicating site of active bronchial bleeding. (small arrow)**

lizing this artery with gelfoam particles (Fig. 8). The systemic nonbronchial arteries and pulmonary arteries may become the important blood-supplying and collateral arteries when the bronchial artery has been embolized[17]. So, for complete evaluation of hemoptysis, systemic nonbronchial arteries and the pulmonary artery should be included, in patients with bronchogenic carcinoma.

Prior to BAE, chest radiograph and bronchoscopic examinations are the two guidelines for BAE. For most of our cases, the bronchoscopic examination was not performed, especially for those cases of massive hemoptysis with impending shock. The chest radiograph in some cases may be the only guideline for BAE, which may not correspond well to the angiographic lesion especially for those cases with many lobar involvements (Table 4). Therefore, the angiographic procedures performed in these cases should include angiographic studies of both lungs including bronchial and intercostal arteries. Active TB cavity in the plain chest radiograph is well correlated with pseudoaneurysm in the angiogram as seen in case 6 (Fig. 7A and 7B).

Chest radiograph may show an extensive lesion due to pulmonary hemorrhage such as presented in case 5, (Table 1) which showed consolidation in the entire right lung in the initial chest

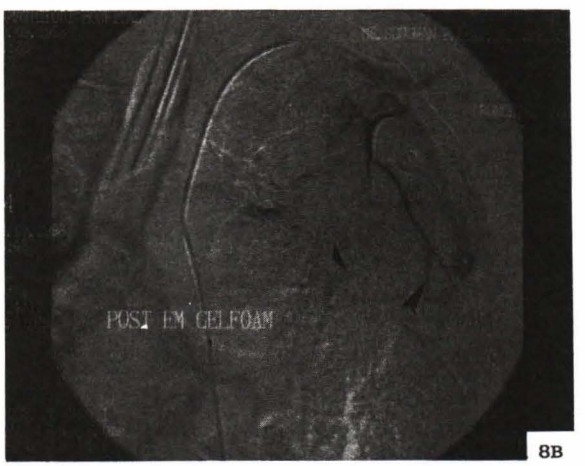

Fig. 8B. **Case 1. Post BAE with gelfoam particles shows complete occlusion of the feeder (Big arrow) with no extravasation. (small arrow)**

prior to BAE and was mistaken for extensive tuberculosis. Actually, the final post-BAE chest radiograph taken after recovery from massive hemoptysis showed only active tuberculosis in the right upper lobe (Fig. 9, 10). The cases with chronic hemoptysis showed a higher recurrent rate (2 of 5

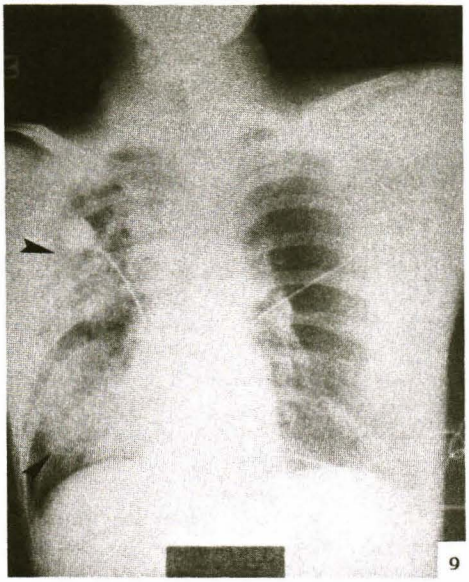

Fig. 9. Case 5 (as in Fig. 5A, 5B, 5C). PA chest prior to BAE shows extensive consolidation of the entire right lung. (Big arrow)

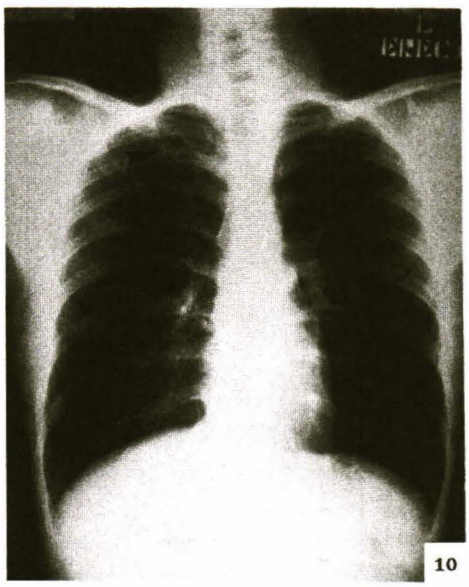

Fig. 10. Case 5. Post BAE of the feeder with gelfoam particles (see Fig. 5B and 5C) and follow-up chest after 10 days shows almost clearing of the consolidation in entire right lung (seen in Fig. 9) with only infiltration seen in right apical lung (Big arrow). Actually the extensive lesion in Fig. 9 is due to pulmonary hemorrhage.

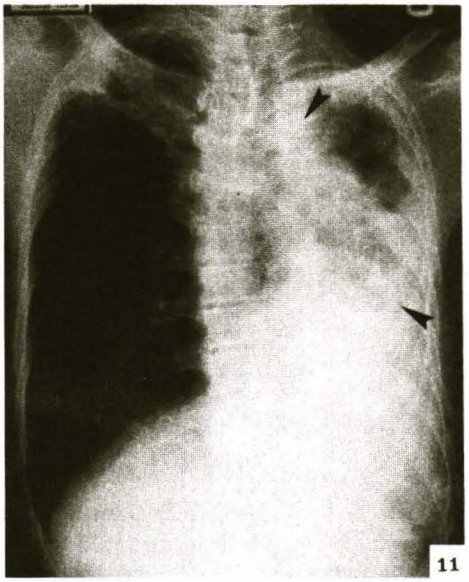

Fig. 11. Case 7. Chronic recurrent hemoptysis occurred one month after first BAE. PA chest shows pulmonary lesion in entire left lung and right upper lobe, actually this case needs thoracotomy of left lung in order to get rid of lesion and prevent recurrent hemoptysis.

cases) than cases with massive hemoptysis (1 of 5 cases). Many factors may explain the higher recurrent rate; the important one being the basic disease as primary cause of hypervascularity or the inflammatory lesion never receiving a thoracotomy (Fig. 11). With temporary embolized materials such as gelfoam particles, although easy to use, the embolized artery may recanalize and may rebleed easily [22]. Recently, Ivalon (polyvinyl alcohol) 300-600 micron was successfully used for permanent embolized effect in 2 cases of recurrent chronic hemoptysis after first BAE (cases 8, 9) and in last case (case 10) with chronic hemoptysis from bronchogenic carcinoma.

The spinal artery arising from the bronchial artery, which was previously considered by some authors to be contraindicated for BAE[17], can be safely done using a microcatheter, as recommended by Ramakantan R[21]. The catheter can be easily introduced in the bronchial artery beyond the spinal artery as shown in case 5 (Fig. 6B) by gradually embolizing the distal bronchial artery with tiny pieces of gelfoam particles.

Active pulmonary tuberculosis remains a major health problem in urban communities. Approximately one-third of the patients with pulmonary tuberculosis will bleed to some extent at various stages of the disease[23]. The incidence of significant hemoptysis in patients with tuberculosis is about 8 per cent[24], and fatal hemoptysis is reported in the range of 1 to 5 per cent[23]. It can occur as well in patients with active tuberculosis who have not been adequately treated with chemotherapy and who exhibited thick-wall cavities (case 6). BAE is an effective life-saving method for patients with massive hemoptysis. Usually tuberculosis is cured by chemotherapy alone without complications in 80-90 per cent of all patients[23]. The remaining patients are prone to have chronic lung disease develop with a high incidence of massive hemoptysis. For chronic tuberculosis, BAE may be an adjunct for chemotherapy to prevent the development of massive hemoptysis. All our patients with chronic hemoptysis showed promising results after BAE. We encourage using Ivalon for the permanent embolizing effect and to prevent recurrent hemoptysis.

Bronchogenic carcinoma receives its blood supply from multiple sources other than the bronchial artery and invades the vascular structure aggressively causing massive hemoptysis as seen in case 1, and immediate BAE is necessary as a life-saving procedure.

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การรักษาภาวะไอตกเลือดโดยการอุดหลอดเลือดบร็องเฆียลทางหลอดสวน

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ภาวะไอตกเลือดที่พบบ่อยคือ จากวัณโรคปอดทั้งชนิดฉับพลันและชนิดเรื้อรัง โดยปกติโรคนี้สามารถรักษาด้วยยาได้ และ 80–90 เปอร์เซ็นต์ของผู้ป่วยจะหายขาดจากโรคนี้หลังให้ยาตามที่กำหนด ผู้ป่วยประมาณ 10 เปอร์เซ็นต์ ที่มีไอเรื้อรังและบางครั้งไอตกเลือดไม่หายขาดจากการรักษาด้วยยา มีผู้ป่วยประมาณ 8 เปอร์เซ็นต์ ที่ไอตกเลือดอย่างรุนแรงและถ้าภาวะไอตกเลือดในปริมาณมากกว่า 300 ซี ซี ใน 24 ชั่วโมง ถือว่าเป็นภาวะไอตกเลือดอย่างหนักซึ่งอาจถึงตายได้จากภาวะช็อกจากการขาดเลือดหรือระบบลมหายใจติดขัดจากการขาดออกซิเจน ได้ทำการรักษาผู้ป่วย 8 ราย ที่ไอตกเลือด 4 ราย เป็นชนิดฉับพลันและไอตกเลือดอย่างหนักจากวัณโรคจนเกือบเสียชีวิต และอีก 4 ราย เป็นชนิดไอตกเลือดจากวัณโรคเรื้อรัง การรักษาด้วยการสอดหลอดสวนเข้าไปที่หลอดเลือดแดงบร็องเฆียลของปอด และอุดหลอดเลือดที่เป็นโรคนี้ ด้วยสารเจลโฟม ซึ่งเป็นสารสำหรับอุดหลอดเลือดชนิดชั่วคราว ห้ามเลือดที่เป็นพยาธิได้สำเร็จ การติดตามผลพบว่ามีผู้ป่วย 1 ราย เสียชีวิตจากการเกิดภาวะไอตกเลือดอย่างรุนแรง 2 สัปดาห์ หลังทำการรักษาดังกล่าวผู้ป่วยที่เป็นวัณโรคเรื้อรังและไอตกเลือด พบว่ามีการกลับมีอาการของโรคอีกคือ มีอาการไอตกเลือดเป็น ๆ หาย ๆ เกิดขึ้นมาใหม่หลังทำการรักษาด้วยการอุดหลอดเลือดของปอดไป 1 เดือน พบในผู้ป่วย 2 รายใน 5 ราย และได้ทำการรักษาด้วยการสอดหลอดสวนเข้าหลอดเลือดแดงบร็องเฆียลของปอด และอุดหลอดเลือดที่เป็นพยาธิ โดยใช้สารพวกไอวาลอน ซึ่งเป็นสารที่อุดหลอดเลือดแดงชนิดถาวร ผู้ป่วย 2 รายนี้ไม่มีอาการหรือภาวะไอตกเลือดอีกเลย ในการติดตามผู้ป่วยมา 2 เดือน

มีผู้ป่วย 2 รายที่เป็นมะเร็งปอดชนิดร้ายแรง และโรคลุกลามไปหลอดเลือดแดงของปอดหรือหลอดเลือดแดงบร็องเฆียล ผู้ป่วย 1 รายใน 2 รายนี้มีอาการไอตกเลือดชนิดรุนแรงมากจนเกือบเสียชีวิต อีก 1 รายไอเรื้อรังจากมะเร็งปอดทำลายหลอดเลือดแดงบร็องเฆียล ได้ทำการรักษาผู้ป่วย 2 รายนี้โดยวิธีดังกล่าว ผู้ป่วยทั้ง 2 ราย ไม่มีอาการไอตกเลือดอีกเลยหลังรับการบำบัดรักษา

ลักษณะภาพที่ปรากฏของหลอดเลือดบร็องเฆียล ในผู้ป่วยทุกรายจากการฉีดสารทึบรังสีเข้าหลอดเลือดนี้บริเวณที่เป็นพยาธิมีหลอดเลือดมาเลี้ยงมากมาย ซึ่งถือเป็นลักษณะเฉพาะเจาะจงของภาวะนี้และสามารถอุดหลอดเลือดเหล่านี้ได้และรักษาภาวะนี้ด้วยการอุดหลอดเลือดแดงบร็องเฆียลโดยใช้สารอุดหลอดเลือดดังที่กล่าวมาแล้ว

คำสำคัญ : ภาวะไอตกเลือด, หลอดเลือดบร็องเฆียล, การอุดหลอดเลือด

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